# HOUSEHOLDS' WILLINGNESS TO PAY FOR IMPROVED ELECTRICITY SUPPLY IN THE ACCRA-TEMA METROPOLITAN AREAS

BY

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# DECLARATION

This is to certify that this thesis is the result of research undertaken by Kwame Adjei-Mantey towards the award of the Master of Philosophy (MPHIL) degree in Economics at the Department of Economics, University of Ghana.

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# ABSTRACT

Electricity is an essential commodity that affects every sphere of life. It is especially fundamental for emerging economies whose national developmental agenda require constant availability of power. Ghana depends heavily on electricity to carry out most of its activities. The industry, services sector, and households all need electricity for their activities. Unfortunately, a major problem that confronts the nation is the irregular and unreliable supply of electricity. Electric power usually goes off indiscriminately and in most cases without prior notification to consumers. Households suffer reduction in utility since some leisure activities cannot be undertaken in the absence of electricity. In addition household appliances are not left without damages when the power supply is erratic. Industries on the other hand have to bear increased costs of production by acquiring back up facilities to be able to continue production during power outages. Smaller firms which cannot afford backups are compelled to stop production altogether when there is no power.

This study therefore seeks to investigate how much households in the Accra-Tema metropolitan area are willing to pay for improved electricity supply as well as examine the factors that influence households' willingness to pay using a contingent valuation survey and the ordered probit econometric model. The study collects cross sectional data from a sample of 358 households drawn from different suburbs within the metropolis. Using a face-to-face interview approach, a discrete choice with follow-up elicitation technique was used to collect the data.

Results from the study reveal that households are willing to pay a significant amount to improve electricity supply. The mean willingness to pay was found to be GH¢ 0.2667, an amount nearly 47% higher than current average tariffs. The significant factors that affect the willingness to pay of households are household income, tertiary educational level of respondents, size of household, sex of respondents, and the reliability of current supply of electricity.

It is recommended that government should invest heavily in power infrastructure to improve electricity supply and subsequently increase tariffs since the people are prepared to pay for it. Increasing household incomes by improving the national daily minimum wage and creating employment opportunities as well as measures to promote formal education in the country to higher levels are among the recommendations made

in this study. Further studies are recommended to estimate the total costs to be incurred in providing a reliable electricity supply system such as the one used in the hypothetical case.

# DEDICATION

I dedicate this work to my family, my loved ones, my friends, lecturers and colleagues who have encouraged, supported and spurred me on in diverse ways throughout my academic life.

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Special thanks go to all friends and loved ones whose diverse support helped me complete this thesis particularly Dr. Yaa Darko, Miss Millicent Awuku as well as students who helped as enumerators in the course of undertaking this study. I appreciate Dr. D. K. Twerefou for funding the survey conducted for this work. I also thank my colleagues from the Department of Economics, University of Ghana. I'm grateful for the opportunity to go through this program of study with them.

Finally, I wish to take full responsibility for any inadvertent errors, omissions or misrepresentations that may be found in this work.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| AAF | Automatic Adjustment Formula |
| ABM | Averting Behaviour Model |
| AC | Alternating Current |
| ARUM | Additive Random Utility Model |
| AT | Akosombo Textiles Limited |
| BGC | Bulk Generation Charge |
| BSP | Bulk Supply Point |
| BST | Bulk Supply Tariff |
| CEAR | Center for Economic and Allied Research |
| CEM | Choice Experiment Method |
| CPI | Consumer Price Index |
| CV | Contingent Valuation |
| CVM | Contingent Valuation Method |
| DBT | Decreasing Block Tariff |
| DC | Direct Current |
| DCAM | Damage Cost Avoided Method |
| DSC | Distribution Service Charge |
| ECG | Electricity Company of Ghana |
| ECOWAS | Economic Community of West African States |
| EUT | End User Tariff |
| Ghp | Ghana Pesewas |
| GRIDCo | Ghana Grid Company |

| | |
|---|---|
| GSS | Ghana Statistical Service |
| GLSSS | Ghana Living Standards Survey |
| GWh | Gigawatt hour(s) |
| HPM | Hedonic Pricing Method |
| IBT | Increasing Block Tariff |
| ISSER | Institute of Statistical, Social and Economic Research |
| MPM | Market Price Method |
| MoEN | Ministry of Energy |
| MW | Megawatt(s) |
| NED | Northern Electricity Department |
| NEDCo | Northern Electricity Distribution Company |
| NES | National Electrification Scheme |
| NOAA | National Oceanic and Atmospheric Administration |
| PFM | Production Function Method |
| PURC | Public Utilities Regulatory Commission |
| PWD | Public Works Department |
| RCM | Replacement Cost Method |
| RUM | Random Utility Model |
| SCM | Substitute Cost Method |
| TCM | Travel Cost Method |
| TEV | Total Economic Value |
| TICo | Takoradi International Company |
| TSC | Transmission Service Charge |

| | |
|---|---|
| TT2PP | Tema Thermal Power Plant 2 |
| VRA | Volta River Authority |
| VALCO | Volta Aluminium Company |
| WAGPCo | West Africa Gas Pipeline Company |
| WTA | Willingness to Accept |
| WTP | Willingness to Pay |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Study

Electricity is a very essential commodity that affects every sphere of life. It is vital for residential, social, commercial as well as industrial uses. It is especially fundamental for emerging economies whose national developmental agenda require constant availability of power. Ghana, for example, depends heavily on electricity to carry out most of its activities. The industry, the mining sector, and the services all need electricity to carry out their activities. Lack of availability of this commodity will therefore affect revenue to individuals, families, industries, civil societies and the nation as a whole.

Many households rely on electricity for performing domestic activities like cooking, washing, ironing, and lighting, among others. With technological advancement, people have become more and more dependent on electric power since most of these technological devices are powered by electricity.

As at the year 2004, electricity supply in Ghana had a customer base of about 1.4 million and Ghanaians consumed 5,158 gigawatt hours (GWh) of electricity that year. The quantum of electricity consumed increased steadily from the 5,158 GWh in 2004 to 9,994.23 GWh in 2011. This showed that demand for the supply of electricity has been trending upwards. About half of the amount of electricity consumed domestically is estimated to be consumed by residential consumers for household uses such as lighting, ironing, refrigeration, air conditioning, television, radio and the like (ISSER, 2005). Commercial and industrial users accounts for the other half of domestic consumption.

In recent times however, people do engage in income earning activities from their homes using their computers and the internet while others engage in small scale economic activities such as tailoring, corn milling and hairdressing, among others that require electricity. Leisure, which is an important argument in a worker's utility function, is also impacted by electricity since some acts of leisure may require the use of electric power. In fact it is becoming extremely difficult to live without electricity, especially in the cities where the benefits of electricity are more visible to residents. Due to this heavy reliance on electricity, residents of both urban and rural communities always agitate whenever electricity supply is interrupted by the authorities concerned.

Growth in electricity consumption has been hovering around 10% to 15% per annum and researchers projected that growth in electricity demand was likely to surpass overall economic growth as well as population growth in Ghana (Energy Commission, 2011; ISSER, 2005). This projection could have been a fact but for the recent discovery and exploration of oil in Ghana which helped shoot the overall economic growth in Ghana to about 13% for the year 2011. That notwithstanding, electricity demand continues to grow because urbanization allows newly urbanized segments of the population to expand their electricity consumption.

Four major institutions are responsible for electricity delivery in Ghana. They are the Volta River Authority (VRA), Ghana GRID Company (GRIDCo) the Electricity Company of Ghana (ECG) and the Northern Electricity Department (NED), a subsidiary of the VRA. The VRA is responsible for production or generation of the electricity using their various hydro and thermal plants. The Ghana GRID Company was established out of the VRA to separate transmission functions of the VRA from its other activities within the framework of the power sector reforms. Thus GRIDCo is primarily responsible for undertaking economic dispatch and transmission of electricity from wholesale suppliers (the generating companies) to bulk customers, which include the Electricity Company of Ghana (ECG), Northern Electricity Department (NED) and the Mines. The ECG and NED are responsible for distributing the electricity to the final consumers within their respective areas of jurisdiction. They take electricity in bulk from the transmission body – GRIDCo and further distribute it to households, commercial units, industries and other users for their consumption. The NED, a subsidiary of the VRA, is responsible for distribution in the northern regions and the Brong Ahafo Region while the ECG takes responsibility for distributing electricity in the rest of the country.

The electricity producing and distributing institutions, being human institutions and especially state owned institutions have their own fair share of internal challenges. Ineffective management practices and laxity on the part of workers are somehow responsible for the inefficient supply of electricity to consumers. Furthermore, some members of the public do not pay electricity tariffs by making illegal connections to their homes and offices, sometimes even with the help of staff of the ECG and NED. These factors among others have made it difficult for the producers, transmitters and the distributors of electricity to provide constant power supply devoid of interruptions.

## 1.2 Problem Statement

Despite the importance of electricity to many households in Ghana, electricity supply has never been reliable. Power usually goes off indiscriminately and in most cases without prior notification to consumers. Many factors are responsible for such unreliable electricity supply. These include the high demand for electricity which exceeds supply, inconsistent supply of gas from the West Africa Gas Pipeline Company (WAGPCo) to feed power plants in Ghana – a situation which may be beyond the control of local utilities, distribution and transmission challenges faced by the Electricity Company of Ghana (ECG), Northern Electricity Department (NED) and the Ghana GRID Company (GRIDCo) such as obsolete infrastructure, poor planning, among others. This, coupled with the low capacity to repair broken down power infrastructure on time have contributed to power interruptions. In the year 2012, for example, interruptions in the supply of gas to the Volta River Authority caused a shutdown of the Sunon Asogli Power Plant which runs solely on gas and adds 200 megawatts to the country's power supply. This resulted in load shedding for many months in that year. Furthermore, the utilities report low cost recovery, resulting from consumers, particularly households paying lower tariffs than the average cost of production (ECG, 2013). This has been a concern for the service providers over the years. Government regulation, mostly for equity reasons, has on many occasions allowed consumers of electricity to pay less than the cost of the electricity they consume. Before the establishment of the Public Utilities Regulatory Commission (PURC) in 1997 for example, the average tariff for final electricity was below 5 US cents per KWh until 1998 when it was raised to between 5.2 - 8.2 US cents per KWh (ISSER, 2005). These tariffs were below cost recovery as reported by the utilities and made it difficult for the power producers to recapitalize.

Since the establishment of The Public Utilities Regulatory Commission (PURC), steps have been taken to progressively increase tariffs to cost recovery levels but the real cost effective tariff level is yet to be achieved, especially for household consumers. There have been constant concerns raised by Ghanaians for the government and service providers to improve upon electricity service delivery. This is due to the fact that households do suffer economic losses in the event of unannounced power outages to the point that many of them may be willing to pay higher tariffs if that will ensure an improved supply of electricity.

Some of the economic losses that households are bound to experience in the face of erratic power supply include reduction in utility since leisure activities which require the use of electricity cannot be undertaken in the event of power outages. Household electrical appliance such as televisions, refrigerators, deep freezers, microwave ovens and others are not left without damages. Frequent and unannounced outages may be accompanied by electrical shocks which the appliances may not be able to withstand causing them to break down. This becomes a loss to the owners who will have to incur extra costs to either repair or replace them. Sometimes food items being preserved in refrigerators go bad when there is no electricity to power their preservation and this is an example of losses which households do suffer under inconsistent power supply conditions.

Of course, how much each household will be willing to pay to improve electricity supply will differ across households depending on the extent to which these power outages cost the households and the individuals therein. The PURC have been cautious in granting tariff increases to the providers by using performance indicators to ensure that inefficiencies are not transmitted to consumers. As a result of these, the providers are confronted with the lack of investment and capitalization which makes it difficult for them to provide uninterrupted service to consumers.

Accompanying the PURC's efforts at increasing tariffs steadily are media reports that evidence the displeasure of some segments of the public whenever electricity tariffs are increased. This may be partly due to the fact that users of electricity do not think the service they enjoy merit increased tariffs. In the midst of these arguments, some of the research questions that may arise are:

- How much are households in the Accra – Tema Metropolis willing to pay for improved electricity supply[1]?
- What factors influence households' willingness to pay (WTP) for uninterrupted electricity supply?
- What is the economic cost of frequent and unannounced power outages to households?

## 1.3 Objectives of the Study

The main aim of this study is to investigate the willingness of households to pay for improved electricity supply. Other specific objectives to be investigated in this study include:

- factors that affect households' WTP
- economic costs of frequent and unannounced power outages to households

## 1.4 Justification for the study

The need for an improved electricity supply, especially in urban areas cannot be over emphasized. Similar studies in this area have been conducted in more advanced countries such as Sweden, Belgium among others (Carlsson and Martinson, 2004; Pepermans, 2011). These studies revealed that households are willing to pay significant amounts to avoid power outages and willing to accept significant amounts for at least one additional outage in a year. However, power outages are not the norm in these

[1] By improved electricity supply, this study refers to constant (and non fluctuating voltage) supply of electricity that is safe for all household gadgets. Power outages will occur only when repair works need to be done due to spontaneous technical faults and even in the event of such outages occurring, consumers will be pre informed before it occurs. Such outages may not extend beyond two hours.

advanced countries unlike the case in Ghana and most parts of Africa, thus this study fills in the gap so far as literature for Ghana and Africa is concerned.

In Africa, few studies have been conducted into estimating household's WTP for improved electricity (Kateregga, 2009; Abdullah and Mariel, 2010). Uganda and Kenya are among the few countries where research has been carried out in this area. However, the results are inconclusive. While the results of Abdullah and Mariel (2010) showed significant WTP for improvement in electricity supply by a part of their sample, the same could not be inferred from the findings of Kateregga (2009). This necessitates further empirical studies to clear the inconsistencies and to know what exactly the Ghanaian situation will be as far as households' WTP to avoid power outages is concerned.

The study differs from other ones conducted on electricity supply in that, this study will come out with significant factors that influence households' WTP for improved electricity. These factors, which are missing from recent studies, should enable the government to know what policies to undertake and what areas of consumers' lives to influence if WTP for improved electricity supply is to be increased. Some of the studies conducted such as Carlsson and Martinson (2004) fail to come out with any particular demographic factors which affect WTP except whether the outage is planned or not. Pepermans (2011) also fails to consider factors that influenced WTA in his work.

This study is also significant for other reasons as follows: overall, the study will bring to the fore how much power outages are costing households by eliciting their WTP to avoid these outages. This would help the government and the power production and distribution institutions (ECG, GRIDCo and VRA) to have an idea of the economic cost of power outages and consequently put in measures to address the problem. There are no known studies in Ghana on this subject and thus estimates from this study are expected to be invaluable to the utilities. It will also inform the PURC to know how much the average household is willing to pay for improved electricity supply and consequently guide not only tariff adjustments but also the development of performance indicators for the providers.

### 1.5 Organization of the Study

This study is organized in six chapters. Chapter one gives the background to the study, discusses the statement of the research problem and the research questions that arise, the objectives of this study and the justification for this study. Chapter two gives an overview of the electricity sub sector in Ghana. Chapter three reviews the literature in this study area. Both theoretical and empirical literature in the areas of electricity demand and pricing, non market valuation as well as willingness to pay/accept (WTP/WTA) is reviewed in this chapter. Chapter four details the theoretical framework and methodology adopted in this study. The fifth chapter presents and discusses the results from the study. The final chapter concludes the study and offers recommendations for policy based on the findings of this study. Limitations encountered in the course of this study as well as recommendations for further research are also presented in the concluding chapter.

# CHAPTER TWO

# OVERVIEW OF THE ELECTRICITY SUB SECTOR IN GHANA

## 2.1 Introduction

This chapter gives a general overview of the electricity sub sector in Ghana with particular attention to institutions responsible for the provision of electricity. The chapter also touches on the demand and supply of electricity, electricity trade as well as the setting of electricity tariffs and tariff adjustments. Reforms in the provision of electricity and challenges faced by the utility providers in the provision of uninterrupted power supply are also discussed in this chapter.

## 2.2 Electricity Generation and Consumption

The first government sponsored public electricity supply in the country commenced in the year 1914 at Sekondi. It was operated by the Railway Administration which extended supply to Takoradi in the year 1928. Actually, the Public Works Department (PWD) had started a restricted direct current (DC) project during the year 1922. This was followed by a large alternating current (AC) project which commenced in the year 1924. Power was gradually extended to Kumasi, Winneba, Swedru, Tamale, Cape Coast and to other parts of the country. These were before the Akosombo Dam was built in the early 1960s. In the year 1965, the Volta River Authority (VRA) started generating power from the Akosombo Dam. The Ministry of Energy (MoEn) in the year 1989 instituted the National Electrification Scheme (NES) as the government's principal policy to extend electricity to all parts of the country over a 30-year period from 1990-2020. The Electricity Company of Ghana (ECG) has since then been executing national electrification programs on behalf of the government of Ghana and by this, electricity supply has been progressively extended to most parts of the country. Around 4,813 communities have been connected to the grid achieving a national average coverage of about 67% as of December 2010 (Energy Commission, 2011). This exercise continues to date as more communities are added to the national grid from time to time.

The MoEn is the primary institution responsible for formulating, implementing, monitoring and evaluating policies regarding energy- which includes electricity in Ghana.

Electricity passes through three main phases before it gets to the final consumer. Power is first produced by the generating plants then transferred to the transmission grid and then to the bulk load distribution centers. The transmission grid comprises a matrix of substations and transmission lines. From the bulk load distribution, power is distributed to the final consumers.

The main institutions responsible for these phases are the Volta River Authority (VRA), the Ghana Grid Company (GRIDCO) and the Electricity Company of Ghana (ECG).

The VRA was established in 1961 under the VRA Development Act, Act 46 of the Republic of Ghana with the primary business of generating and supplying electrical power for industrial, commercial and domestic use in Ghana. VRA started generation of power from the Akosombo Dam in the year 1965 and later the Kpong Dam downstream of Akosombo in the year 1982. These are the two hydro sources of power generation in Ghana currently. Additionally, the VRA generates power from thermal facilities to augment hydro generation. The thermal facilities run either on light crude or largely on gas mostly supplied through the West African Gas Pipeline Company. Private players have also joined the generation of electricity. Electricity generation has been opened for private players to join to increase the level of generation generally and also to favour fair competition. However, potential private players need to be duly licensed by the Energy Commission before they may start operations. It is the expectation of the power authorities that in the future, electricity distribution will also be open to private investors to improve upon competition and subsequently the quality of service delivery in Ghana.

In the year 2005, following the promulgation of major amendments to the VRA Act in the context of Power Sector Reforms by the government of Ghana, VRA's mandate was revised and now focuses largely on power generation. Its transmission functions have been separated into a distinct entity, the Ghana Grid Company (GRIDCo) to perform transmission activities.

GRIDCo was established in accordance with the Energy Commission Act, 1997 (Act 541) and the VRA (Amendment) Act, 2005 Act 692, which provides for the establishment and exclusive operation of the National Interconnected Transmission System by an independent Utility and the separation of the transmission functions of the (VRA) from its other activities within the framework of the Power Sector Reforms. The company became operational in 2008 following the transfer of core staff and assets from the VRA to GRIDCo. GRIDCo therefore transmits power generated from the VRA to the bulk load distribution institutions for onward distribution of power to final consumers.

Distribution of electricity to final consumers rests mainly on the shoulders of the Electricity Company of Ghana and the Northern Electricity Department (NED), a subsidiary of the VRA. Until 1987, the responsibility for distributing and supplying power in the country rested solely on the ECG. The NED was created as a subsidiary of the VRA and took over from the ECG, the responsibility of running and developing electric power systems for the Brong Ahafo, Northern, Upper East and Upper West regions of Ghana. ECG therefore now focuses on distributing power to the southern part of Ghana comprising the Ashanti, Central, Eastern, Western, Volta and Greater Accra regions. The ECG began as the Electricity Department in 1947 and later became the Electricity Division in 1962. In 1967, it became the Electricity Corporation of Ghana. In 1997, it was incorporated under the Companies code, 1963.

Other institutions related to the supply of electricity in Ghana are the regulatory institutions. Two institutions have been handed regulatory mandates over electricity in Ghana. First, the Public Utilities Regulatory Commission (PURC) is an independent body set up by an act of parliament- Act 538- to regulate and oversee the provision of the highest quality of electricity and water services to consumers. Among the key functions of the PURC are to provide guidelines for rates to be charged for the provision of utility services as well as examining and approving of rates or tariffs. The PURC also monitors and enforces standards of performance for the provision of utility services. The second is the Energy Commission. The Energy Commission also established by an act of parliament- Act 541- is a statutory body corporate with perpetual succession. Among the functions of the Energy Commission is to provide the legal, regulatory and supervisory framework for providers of energy in Ghana i.e. licensing, prescribing uniform rules of practice by legislative instrument, inspection, monitoring and compliance of rules.

## 2.3 Stylized Facts about Electricity in Ghana

### 2.3.1 Trends in Electricity Supply

Electricity in Ghana is generated through hydro sources from the Akosombo and the Kpong Dams and through thermal plants located in Takoradi, Tema and recently Asogli. Table 2.1 shows the electricity produced by the various hydro and thermal plants in gigawatt hours in the recent past from the year 2002 to 2011. In the table, the hydro sums up production from both the Akosombo and Kpong generating stations while the thermal sums up production from the Takoradi Thermal, Takoradi International Company (TICo), Tema Thermal Plant 1, Tema Thermal Plant 2, New Tema Reserve Power Plants, Mines Reserve Plant (MRP), Diesel Station Mines, Kumasi Reserve Power Plant and the Sunon Asogli Power Plant. The aggregation has been done in the table based on the location of the generating plants. It is important to note however, that not all the thermal plants produced power in each of those years. With the exception of the Takoradi Thermal Plant and the Takoradi International Company (TICo) which remained operational continuously for all the years since 2002, the other thermal plants recorded zero production in some of the years. Also worth noting is that the Tema Thermal Plant 2 (TT2PP) and the Sunon Asogli Power Plant started production in the year 2010.

**Table 2.1 Power production (GWh) from hydro and thermal sources from 2002 to 2011**

| Year | Hydro | Thermal | | | | **Total** |
|---|---|---|---|---|---|---|
| | | Takoradi | Tema | Kumasi | Asogli | |
| 2002 | 5035.85 | 2236.92 | 22.76 | - | - | **7295.53** |
| 2003 | 3885.2 | 1996.6 | 18.56 | - | - | **5900.36** |
| 2004 | 5280.91 | 758.13 | - | - | - | **6039.04** |
| 2005 | 5628.73 | 1159.18 | - | - | - | **6787.91** |
| 2006 | 5618.57 | 2810.4 | - | - | - | **8428.97** |
| 2007 | 3726.97 | 2938.71 | 345.3 | 32.63 | - | **7043.61** |
| 2008 | 6295.61 | 1936.61 | 175.55 | 15.9 | - | **8423.67** |
| 2009 | 6877.09 | 1492.75 | 588.79 | 0.17 | - | **8958.8** |
| 2010 | 6995.41 | 2394.08 | 639.01 | - | 137.83 | **10166.32** |
| 2011 | 7560.87 | 1794.68 | 619.43 | - | 1224.17 | **11199.15** |

Source: Institute of Statistical, Social and Economic Research, 2004; 2008; 2012

It is observed from Table 2.1 that electricity supply has increased from 7,295.53GWh in the year 2002 to 11,199.14GWh in the year 2011. This represents an increase of

53.51% over the period and an average annual growth of 5.88%. Production fell in the year 2003 but rose again the following year to 6,039GWh. Generally, an increasing trend is seen in electricity production although occasionally, some particular years have recorded a decline from the previous year's production as seen with the years 2003 and 2007. The decline observed in the year 2007 is attributed to the shortfall in the water level of the Akosombo Dam which led to a shortfall in hydro generation.

In terms of the hydro – thermal generation mix, hydro sources contributed 69.02% total power generation in year 2002 while thermal sources contributed 30.98%. Hydro generation's contribution shot up to an imposing 87.45% in the year 2004 leaving thermal contribution to power generation at only 12.55%. In the year 2007 however, hydro's contribution to total generation fell to 52.91% due to the fall in the water level of the Akosombo Dam. This situation made it possible for thermal generation to contribute almost half of total generation of power in year 2007. The two years following saw thermal generation's share in total power generation fall again as the water level in the dam was normalized. Hydro sources contributed an average of 75.75% to total generation in those two years- 2008 and 2009 leaving thermal sources to contribute less than 25% of power generated. In the year 2010, hydro sources' contribution dropped to 68.8% of total power generation in the country with the remaining 31.2% being contributed by thermal sources. In the year 2011, hydro generation's contribution fell further to 67.5% with thermal generation rising to contribute 32.5% to power generation. The increase in the contribution by thermal sources in the latter years is largely due to the addition of two thermal plants to mainstream generation in the year 2010. They are the Tema 2 Thermal Plant and the Sunon Asogli Power Plant. The Sunon Asogli plant for instance contributed 1,224.17 GigaWatt hours (GWh) of the total 11,199.14 GWh of electricity produced in 2011.

This was a phenomenal increase from the 137.83 GWh the Sunon Asogli plant contributed to the total of 10,166.32 GWh of electricity produced in the year 2010. It remains, however, that at present, Ghana's electricity is mainly hydro generated.

### 2.3.2 Domestic demand trends of electricity in Ghana

Individual units of electricity consumers take their supply from bulk customers. These bulk customers are mainly the distribution institutions (ECG and NED). These institutions demand the electricity on behalf of individual units and subsequently distribute to the end users. Latest statistics for the year 2011 shows that 72% of domestic electricity demand was distributed by the ECG with the NED distributing 7% of domestic demand. The mines (New Obuasi, New Tarkwa, Bogoso and Kenyasi) made up 13% of domestic demand while 'other bulk customers' consumed 8% of domestic demand as shown in Figure 2.1. 'Other bulk customers' are those consumers of electricity whose electricity are delivered directly by the VRA without going through the distribution companies. They include Volta Aluminium Company (VALCO), Akosombo Textiles Ltd (ATL), VRA Townships, Export Free Zone, Diamond Cement, Vodafone, TV3, Aluworks among others (ISSER, 2012).

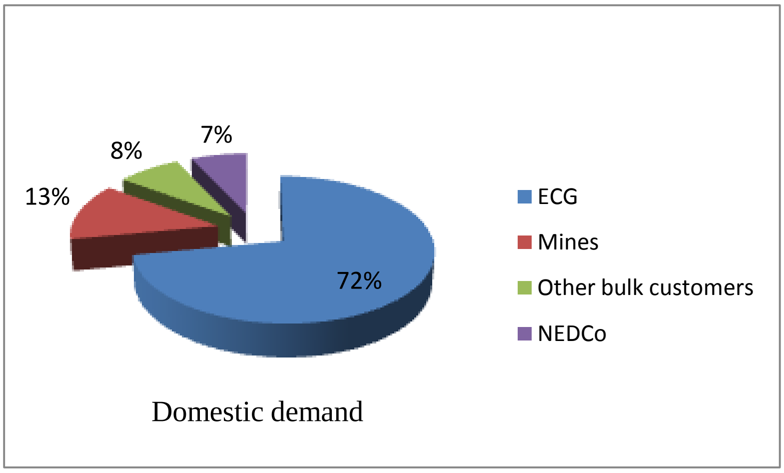


**Figure 2.1: Total Domestic Demand of Electricity by various users.**

Source: Institute of Statistical, Social and Economic Research, 2012

From Figure 2.1, it is evident that the ECG remains the largest distributor of electricity in Ghana. This is due to the number of customers under its jurisdiction. As previously discussed, the ECG distributes to six out of the ten regions in Ghana. These six regions include the most populous regions in the country and together make up for 73.5% of total population (GSS, 2012). It is therefore appropriate that the ECG takes a chunk of the electricity generated for consumers under its jurisdiction.

Domestic demand of electricity has seen an increasing trend generally. Table 2.2 shows the levels of domestic demand of electricity from the year 2005 to 2011.

**Table 2.2 Domestic Demand of Electricity from 2005 to 2011 (GWh)**

| 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| 6671.85 | 7935 | 7447.77 | 8262.16 | 8018.07 | 8808.48 | 9994.23 |

Source: Institute of Statistical, Social and Economic Research, 2012

From Table 2.2, it can be noted that demand for electricity in Ghana has recorded a steady rise since the year 2005. Demand stood at 6,671.85GWh in the year 2005 but by the year 2011, it had increased to 9,994.23GWh representing an increase of 49.8% over the period and an average annual growth of 7.35%.

Figure 2.2 shows the levels of domestic production against the levels of domestic demand and the resulting excess production over domestic demand of electricity from the year 2005 to 2011.

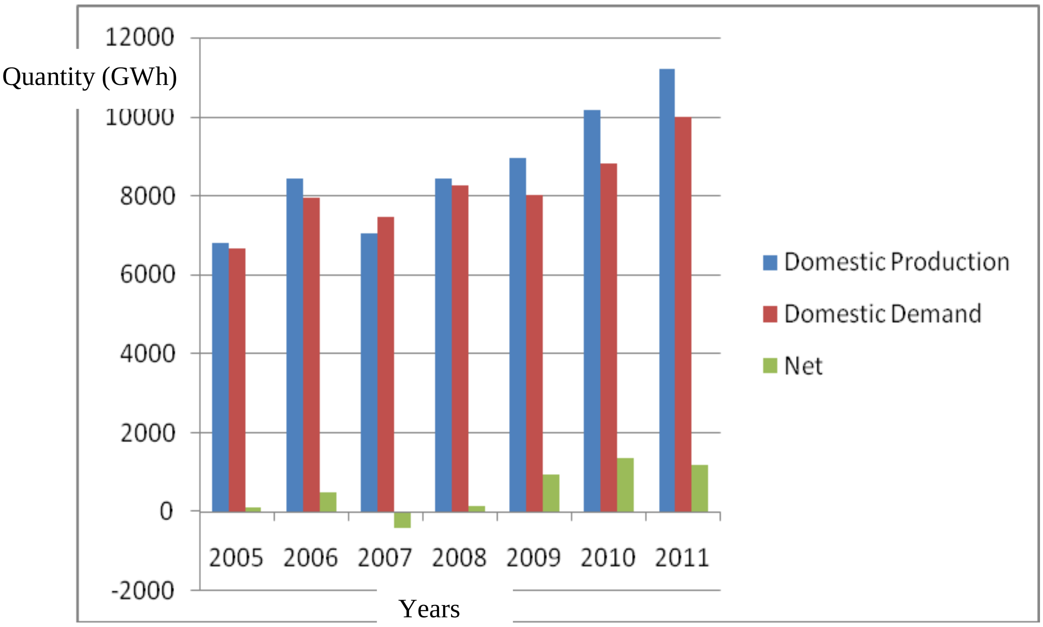


**Fig 2.2 Domestic demand, domestic production and excess production over domestic demand of electricity from 2005 to 2011**

Source: Author's computation with information from Institute of Statistical, Social and Economic Research, 2012.

It must be noted that the balance between supply of and demand for electricity is to a large extent a major determinant of the reliability of electricity in Ghana. From Figure 2.2, it can be seen that for the past seven years, domestic production has always exceeded domestic demand except in the year 2007 when the reverse was observed.

The fall in production in the year 2007 notwithstanding, domestic demand like domestic production has seen an upward trend generally over the period. The years following the year 2007 till date have seen progressive increment in levels of demand. Domestic demand may have risen due to an increase in the general population of the country and hence increased number of people who demand electricity for their daily activities. Additionally, urbanization allows for newly urbanized segments of the population to expand their electricity consumption thus accounting for increased demand. On the production front, apart from explaining the progressive increment observed lately by the fact that more thermal plants have been established and have added to the country's generating stock, the VRA is increasing the installed capacity of some of the thermal plants such as the conversion of the 220MW thermal plant of Takoradi International Company (TICo) into a 330MW combined cycle plant. This is in a bid to increase production of electricity domestically.

The increased production levels and the VRA's efforts at increasing installed capacities of some of her plants notwithstanding, power outages still do occur in the economy. This may be due to the fact that not all the power domestically produced is consumed domestically. Some of the power produced is exported as power is equally imported into the country depending on the needs of trading partners.

### 2.3.3 Imports and Exports of Electricity

In the year 2003, Ghana signed the ECOWAS Energy Protocol which eliminates cross border trade barriers to energy trade and facilitated investment in the energy sector. Ghana therefore trades electricity with neighbouring Cote D'Ivoire, Togo and Burkina Faso. The difference between imports and exports of electricity is the net imports. If this difference is positive, it implies that imports for a particular year are greater than exports of electricity for that year. If this happens to be the case, then just as a positive net imports for any other good or service does, there will be a reduction in the country's foreign reserves. In like manner, negative net imports will improve the country's foreign reserves. Figure 2.3 shows the levels of imports and exports of electricity and the net imports from the year 2004 to 2011.

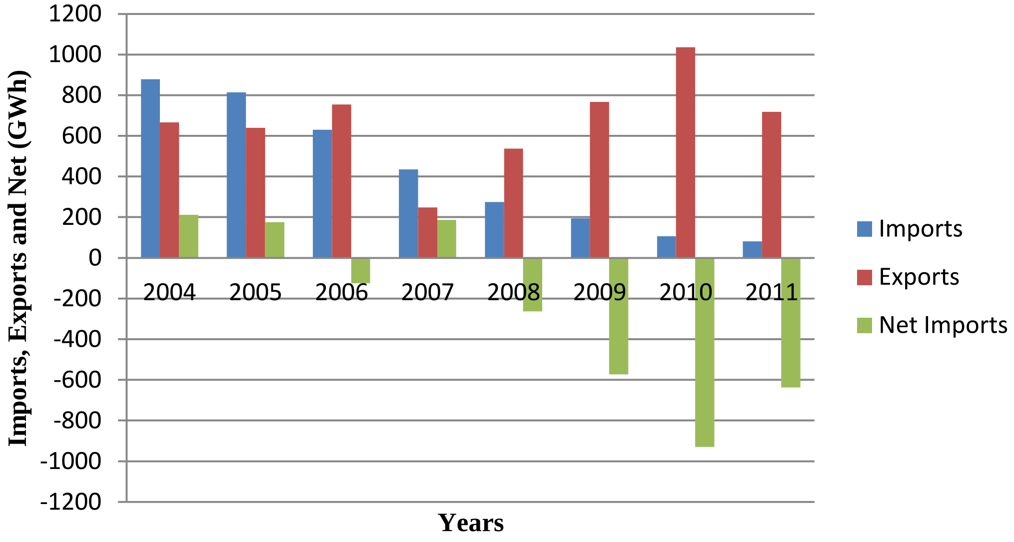


**Figure 2.3 Imports, exports and net imports of electricity from 2004 - 2011**

Source: Author's computation with information from Institute of Statistical, Social and Economic Research, 2012

Figure 2.3 shows that Ghana imported more electricity than she exported in the years 2004, 2005 and 2007. This could be the result of low level of domestic production in these years. More electricity had to be imported to augment domestic production to meet domestic demand. As such net imports for these years were positive. However, in the years 2006, 2008 and after, exports have exceeded imports yielding negative net imports of electricity. This could be due to the fact that Ghana has consistently improved her power generation in the last few years with the building of additional thermal plants such as the Tema 2 thermal and the Sunon Asogli plants as mentioned earlier to augment power generation. This situation of negative net imports is expected to improve in future years especially as the government of Ghana in the year 2007 negotiated a US$ 622 million loan for the construction of the Bui dam and Bui city. The country in May 2013 began receiving power from the Bui dam and more is expected in the coming years. Additionally, measures are in place to increase the dependable capacities of the existing plants to increase the power they generate. A

132MW plant at Aboadze is also ongoing and hence domestic production is set to rise (VRA, 2012).

## 2.4 Electricity Tariffs

The price consumers pay for electricity is the tariff. From demand theory, the price of a commodity determines the quantity of the commodity consumed. Electricity consumption is usually done before payment is made (post paid). With the recent introduction of the prepaid billing system, consumers purchase some units of the electricity before consuming. With the post paid billing system, consumers consume the electricity and are billed at the end of the month for how many kilowatt hours (KWh) they consumed. A pilot study conducted by the author of this thesis has revealed that most people do not even know the price charged per KWh of electricity. Thus demand for electricity may not necessarily follow conventional demand theory where quantity consumed depends on the price although most consumers being rational attempt to reduce the amount they pay at the end of the month by conserving electricity as much as possible. One reason that may account for this is that electricity is considered a necessity. Most people therefore consume the electricity as they need and pay whatever amount that is billed them at the end of the month.

From literature there are typically three tariff schemes for electricity pricing. They are the constant tariffs, increasing block tariffs and the decreasing block tariffs (Adom, 2011). With the constant tariffs, consumers pay the same price irrespective of the quantity of KWh consumed. The increasing block tariff scheme is a system that makes the consumer pay higher tariffs as his quantity of KWh consumed increases. This system advocates for energy conservation and efficient use of electricity since rational consumers would be particular about energy conservation in order to reduce their total amount of money spent on electricity. With the decreasing block tariff scheme, the consumer pays lower tariffs as his consumption per KWh of electricity increases. This system is to encourage the use of electricity as against other forms of energy. Since the consumer is made to pay a lower tariff as his consumption increases, he is likely to consume more KWh of electricity to benefit from the lower tariffs.

The increasing block tariff scheme is more probable to be practiced in an economy where electricity production is low with a high demand for it while the decreasing block tariff is more likely in an economy where electricity is produced in abundance or where other forms of energy is scarce or more costly to produce.

Essentially, the final tariffs paid by consumers are into different components. The Bulk Generation Charge (BGC), Bulk Supply Tariff (BST), Transmission Service Charge (TSC), Distribution Service Charge (DSC). These together make up the End-user tariff (EUT).

BGC are charges paid to the distribution utilities to cover the costs of procuring electricity from wholesale power suppliers. BST represents the maximum charge approved by PURC for the procurement of capacity and energy at each Bulk Supply Point (BSP) that distribution utility companies shall be allowed to recover from customers through the End-User tariffs. The BST is the price of electricity at the Bulk Supply Points. Transmission service charges (TSC) are charges paid to the Transmission institution for the provision of transmission services. It is important to know that the BST is the sum of capacity and energy purchases from the wholesale power supplies and transmission service charges (PURC, 1999). In other words, the BST includes bulk generation charges due the generating plants plus transmission service charges. Distribution service charges (DSC) are charges paid to the distribution companies to cover their cost of providing services. The End-User tariff (EUT) is the sum of the BST and DSC (ISSER, 2005). EUT is the retail price charged to the end-user by distribution companies.

There are different tariffs for industrial, commercial (non-residential) and residential customers. The tariff for residential customers has a 'lifeline' tariff for low users of electricity, which was set at 100 KWh per month maximum in 1989/90 but was downgraded to 50 KWh per month maximum by the year 2000. This is still high compared to those of neighbouring countries. For instance it is 20 KWh in Benin and 40 KWh in Togo (ISSER, 2005). This higher 'lifeline' level is indicative of a relatively higher level of welfare being enjoyed by the average Ghanaian compared to people living in countries with lower 'lifeline' levels. EUT applies to all customer categories except the 'lifeline' consumers.

The 'lifeline' consumers refer to those consumers who consume less than or equal to 50 KWh of electricity per month. The idea behind the 'lifeline' consumer policy is that electricity is regarded as a necessity and a requisite for development. Thus, all persons irrespective of their social and/or economic status must have equal access to electricity. Low income persons who cannot afford the full cost of electricity must still be provided with the service. As a result 'lifeline' consumers pay a low fixed rate as service charges basically.

The rate as well as the 'lifeline' consumption level is both determined by the PURC and the decision is influenced by such factors as the national minimum wage, ability to pay for rural consumers, the price of a gallon of kerosene and the average cost of hydro. Beneficiaries of the 'lifeline' consumption rate are also determined by PURC. The PURC considers the national daily minimum wage in determining the lifeline level and rate because according to the regulatory body, the World Bank stipulates a certain maximum percentage of a person's income that should be spent on utilities.

Electricity tariffs in Ghana have been generally low compared to some countries in West Africa (Adom, 2011). This could be explained by the fact that Ghana's electricity is generated mainly through hydro sources. These hydro facilities were built several years ago and the cost of production is generally low resulting in low tariffs. Infact, according to a research by ISSER (2005), electricity is usually first dispatched from hydroelectricity stations since it is cheaper per KWh to produce electricity from these sources as long as there is water available for that. It costs more to generate power via thermal sources than via hydro sources.

### 2.4.1 Tariff Setting/Adjustments

The PURC is the institution responsible for tariff adjustments in Ghana. They examine and approve the tariffs and grant adjustments as and when necessary. Tariffs are adjusted in two ways.

The first is the major tariff review. This is officially scheduled to take place after every four years. However, conventionally the PURC reserves the right to undertake a major tariff review before four years from the last. Under the major review, all stakeholders concerned are consulted and subsequently, tariffs are reviewed taking cognizance of factors such as investments in the service delivery by the service providers, new introductions into the service supply, among others. These investments and new introductions call for a review of the rates since they have to earn good returns like any other investment. Thus, the PURC considers these and subsequently rewards the service providers with commensurate tariffs.

There are complaints by the providers that besides the factors mentioned above, there are other factors which alter the costs of providing the service for which reason the PURC needs to adjust tariffs to reflect them. These other factors, known as exogenous factors led to the introduction of the Automatic Adjustment Formulae (AAF) in 2002. The PURC at the end of every quarter reviews the electricity tariffs and considers whether or not to grant an adjustment taking these exogenous factors into consideration. The exogenous factors include the hydro – thermal generation mix, average Consumer Price Index (CPI) over the period, the Ghana Cedi – US dollar exchange rate over the period, the prices of fuel especially light crude oil which are inputs for some of the generating plants, among others. If there have been significant changes in these factors, tariffs are automatically adjusted to reflect the changes. However, tariffs may remain unadjusted after a particular quarter if the PURC considers that there have not been any major changes in the factors mentioned above. In other cases, projections of how these factors will turn out are made and tariffs adjusted based on the projections. Should the projections turn out to have deviated from the actual, the body undertakes what is termed as a 'recovery' in which case the subsequent adjustment will be made to take care of either the overshooting or undershooting of the projections.

Table 2.3 shows the BST, DSC and EUT from the year 2001 to 2012.

**Table 2.3 End User Tariff in Ghp/KWh**

| Tariff Components | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BST | 1.94 | 3.59 | 4.27 | 4.25 | 4.25 | 4.94 | 6.11 | 6.11 | 6.11 | 14.21 | 11.94 | 12.58 |
| DSC | 1.96 | 2.64 | 2.92 | 3.15 | 3.15 | 4.5 | 5.85 | 5.85 | 5.85 | 9.88 | 9.45 | 9.76 |
| EUT | 3.9 | 6.23 | 7.19 | 7.4 | 7.4 | 9.44 | 11.96 | 11.96 | 11.96 | 24.09 | 21.39 | 22.34 |

Source: Public Utilities Regulatory Commission

Table 2.3 presents the EUT for the period covering 2001 to 2012. As previously discussed, the BST is the addition of generation charges (BGC) and transmission charges (TSC). Over the period, BST increased from 1.94Ghp /KWh to 12.58Ghp/KWh representing a percentage increase of 548.45%. BST averaged 6.69Ghp/KWh over the period. DSC also recorded an increase from 1.96Ghp/KWh in 2001 to 9.76Ghp/KWh in 2012. . This represents an increase of 397.96% over the period. Average DSC over the period was 5.41Ghp/KWh. EUT increased from 3.9Ghp per kWh to 22.34Ghp per KWh representing a percentage increment of 472.82% over the period and an average annual growth of 20.64%. The average EUT over the period is 11.488Ghp/ KWh.

The upwards adjustments in the tariffs over the years have been due to the increase in thermal composition in the hydro-thermal generation mix. As has been discussed, thermal sources' contribution has seen an increasing trend and thus the higher costs incurred in thermal generation is reflected in the upwards adjustments. In addition, the Ghana Cedi – US dollar exchange rate has risen over the period accounting for the upwards adjustments. The exchange rate stood at GHC 1.00 to USD 1.00 in 2007 but stands at GHC 1.95 to USD 1.00 as at April 2013. What this means is that currently, it costs more to purchase light crude oil to feed generation plants than it did in the past. These are reflected in the upwards adjustments in the EUT over the period.

### 2.5 Reforms in Electricity Production

Some reforms have taken place in the production of electricity. A major one took place in the year 2005 following the promulgation of amendments to the VRA Act. VRA's mandate was restricted to power generation while transmission of electricity was handed to a distinct entity called the Ghana Grid Company (GRIDCo).

Since the establishment of the VRA and the construction of the Akosombo Dam in the 1960s, generating electricity had rested solely on the VRA. The VRA was the sole institution responsible for generating power until power generation was opened up to private investors –another reform in the sector. Interested private investors need to apply for and be granted appropriate licensing by the Energy Commission before they may start operations. In the early 2000s, some companies entered the power generation industry howbeit in partnership with the VRA. The Takoradi International Company (TICo) is one such company that operates a thermal plant in partnership with the VRA. It was not until the year 2008 when the Sunon Asogli plant came on board entirely independent from the VRA. It is envisaged that in the near future, electricity distribution will also be opened up to private players.

Another reform underway is the separation of the NED, a subsidiary of the VRA into a distinct and autonomous distribution institution. The necessary documentation for this separation had been completed as at February 2013 and is pending perusal and affirmation by the appropriate authorities. When this process is completed, the Northern Electricity Department (NED) of the VRA will become the Northern Electricity Distribution Company (NEDCo) and will continue to focus on distribution in the northern parts of the country.

## 2.6 Challenges Faced in Power Supply in Ghana

A major challenge facing the electricity supply institutions is investment. Most of the equipments and infrastructure needed to operate in this sector come at a very high cost thus making it very difficult for private players to join. This is one factor that has created a near natural monopoly for the generating and distributing institutions. The high cost of equipments has made it difficult even for the government or the operating institutions themselves to acquire new and modern equipments to reinvest in their operations. These institutions still operate with obsolete equipments acquired many years ago. These equipments suffer frequent break downs and this impedes the steady supply of electricity. It is not uncommon to hear of repair works being carried out on broken down infrastructure for which reason consumers have to suffer power outages.

In addition, the VRA has reported dwindling capacity reserve margin in the electricity system from 15% in 2010 to under 5% in 2012 as a major challenge it is facing at present. Ideally, this reserve capacity should be at least 20%. With growth in electricity demand being 10% over the past three years, the reserve margin keeps falling and this negatively impacts on electricity supply (VRA, 2012).

On the part of the distributing institutions, nonpayment of bills remains one of the chief problems the entity faces. Revenue collection has not seen the best of efficiency. Various consumers including government agencies owe the distribution agency varied amounts of money running into millions of Ghana cedis. The ECG has reported that the government of Ghana owes it to the tune of GH¢ 537.74 million whiles debt owed by the private sector including households amounts to GH¢ 292.86 million as at December 2012 (ECG, 2013). This obviously is a challenge which impedes reinvestment and better service delivery. The ECG has made attempts to solve this problem by fixing pre paid meters for consumers in which case payments will be made before consumers use electricity. However, this exercise has still not been carried out on a large scale. An exercise which began in the year 2009 to install pre paid meters for all government institutions has not seen much fruitfulness since the exercise has achieved only about 45% coverage as at February 2013 (accessed at www.myjoyonline.com). Post paid metered customers still remain in the majority.

Related to the nonpayment of bills is the challenge of ‘illegal connections’ which has taken roots in some parts of the country. Some members of the public have made electricity connections illegally and without the knowledge of the distributors. This makes the distributors unable to track these persons for billing though they also enjoy the services rendered by the distributing institutions. This is a challenge to uninterrupted supply of electricity in Ghana.

### 2.7 Summary of Chapter

This chapter gave an overview of the situation in the electricity sub sector in Ghana over the past and as it stands in recent times. Electricity generation and the process it goes through till it reaches the final consumer as well as the institutions responsible for all of these stages were discussed. Stylized facts about supply, demand, imports and exports of the service was also discussed where it came to the fore that domestic production of electricity in Ghana has risen in recent years allowing the nation the luxury to export more than she imports; a situation that is creating negative net imports for the country. Similarly, domestic demand for electricity was also seen to have risen over the past seven years. However, production levels remain slightly higher than domestic demand levels. Electricity tariffs and tariff adjustments were discussed where it came to light that electricity tariffs have steadily appreciated over the past ten years. End User Tariffs have recorded an average annual growth of 20.64% over the past ten years and this has helped solve the problem of consumers paying tariffs well below cost recovery levels although the public utilities claim there is more room for improvement. The chapter ended by discussing some challenges facing the sector. Among the challenges discussed are insufficient investments into the activities of the power institutions due to the heavy costs involved, falling capacity reserve margin in the electricity system and distribution institutions' inefficiency in revenue collection was also discussed; a challenge that has led to huge sums of money owed to the institutions.

# CHAPTER THREE

# LITERATURE REVIEW

## 3.1 Introduction

The chapter reviews the relevant literature in the study area. The review incorporates the theoretical and empirical literature. The former focuses on issues such as electricity demand and pricing models as well as the various types of methods that are used for economic valuation whereas the latter focuses on studies conducted in this study area by earlier researchers. The essence of the review is to bring to the fore what has been done and said about the costs of power outages and how much people are willing to pay to improve electricity supply as well as identify which areas are yet to be covered in this study area.

## 3.2 Theoretical Review

### 3.2.1 Models of Electricity Demand and Pricing

Electricity demand has been modeled after conventional demand theory which proposes that the demand for a commodity depends essentially on the price of the commodity, prices of related goods and the income of the consumer. From the literature on electricity demand, these basic factors – price of electricity, price of other sources of energy and real income of consumers- have cut across as affecting electricity demand. However, other factors are reported to influence electricity demand alongside these ones by various studies. Some of these other factors that are likely to affect electricity demand include stock of capital appliances (Narayan and Smyth, 2005); prices of appliances (Diabi, 1998); temperature (Diabi, 1998; De Vita et al. 2006); real GDP per capita (Adom et al. 2012; Babatunde and Shuaibu, undated[2]); industry efficiency (Adom et al. 2012); demographic features (Filippini and Pachauri, 2002; Adom et al. 2012); population (Babatunde and Shuaibu, undated); weather conditions and consumer usage patterns (Foley et al. 2010) and factors likely to influence consumers' tastes such as technology. Interestingly, the work of Babatunde and Shuaibu (undated) finds that own price of electricity, which has been observed to run through many studies as a determinant of electricity demand, was not significant in the demand for electricity.

The own price component of electricity demand has been a difficult component to measure in several electricity demand models. This is because there are typically three electricity pricing schemes as has been discussed in the previous chapter – the increasing block tariff (IBT), the decreasing block tariff (DBT) and the constant tariffs. Each of these pricing schemes imply different relationships between price and the quantity of electricity consumed and this leads to some complexities in measuring the price component of electricity demand.

Having non-linear price schemes such as the IBT and DBT has been of concern in modeling electricity demand. Different researches have applied different strategies to confront this problem. As reported by Adom (2011), some studies have suggested including average or marginal prices as exogenous factors. Others have preferred to include marginal prices and instrumentalize them by all prices in the tariff scheme to arrive at consistent estimates while some have prescribed that all relevant prices be included into a single expression for a given user's consumption.

[2] Babatunde, M. A and Shuaibu, M. I. (undated) 'The demand for residential electricity in Nigeria: a bound testing approach'. Accessed at http://www.africametrics.org/documents/conference09/papers/Babatunde_Shuaibi.pdf

Another issue of concern in modeling electricity demand is the stock of appliances and how that influences electricity demand. The nature and stock of electrical appliances was likely to affect a household's demand for electricity. To deal with this problem, researchers have advocated that applying discrete choice modes, sample selection corrections as well as discrete – continuous combinations would allow for estimating electricity consumption per each appliance owned (Adom, 2011).

## 3.3 Non Market Valuation

### 3.3.1 Economic Valuation of Non Market Goods

Non market goods may refer to goods and services that are not captured in the market place or for which no or limited market exists and for which people do not pay money to receive them. Usually, most environmental goods are non market goods because they exhibit the characteristics above. Not many of such environmental goods have markets and hence prices. The prices that exist for those few indicate that minimum amount at which suppliers and consumers have agreed to enter into a market transaction. At these prices therefore, surpluses are bound to exist either on the producer side or the consumer side. The economic value of such goods thus goes beyond the price to include all the surpluses unaccounted for in the price.

Given that most environmental goods do not have markets and those that do, have prices that do not reflect the full value of the goods, economic valuation is most important to the sustainability of non market goods.

The theory of economic valuation is based on individual preferences and choices (Perman et al. 2003). That is to say, the economic value of a good, service or a resource is based primarily on what people want. It is generally assumed in Economics that individuals are the best judges of what they want given that they are rational. Individual preferences are observed by the choices and the tradeoffs they make. Economic value is measured by the maximum that someone is willing to forego in terms of other goods or services to obtain a good or service. As already discussed, this may be different from the market price since the market price may not accurately measure the economic value. Infact, from conventional demand analysis, most people are usually willing to pay more for a good especially the first units of the good than the price of the good resulting in their WTP going beyond the market price.

The economic value of a resource such as improved electricity supply can be classified into use value and non use value. These together, make up the total economic value (TEV) of the resource, a concept which emerged in the mid 1980s.

Use value refers to the benefits that derive from society's gains from using the resource. For example, society may use a clean river for drinking purposes, swimming, boating, among others without paying for it. This is use value. Use value is further divided into two – direct use value and indirect use value. Direct use value of a resource is the contribution of the resource to current production or consumption or the value derived from directly consuming services provided by the resource. Logging a forest to obtain wood for fuel could be an example of direct use value. Indirect use value of a resource refers to the functional services the resource provides to support current consumption and production (Perman et al. 2003). In the case of the forest, water shed protection is an example of an indirect use value derived from the resource. In the case of electricity, having light to be able to read at night may be considered an example of direct use value whiles having your compound well lighted at night (even though the consumer may be indoors and therefore may not be using outside lights at that moment) to keep thieves and hooligans away may be an example of indirect use value.

Non use value of a resource is the value that individuals attach to a resource in appreciation of the resource and not because they are using the resource. Non use value is the demonstration of people's WTP for a resource regardless of their ability to make any use from it either now or in the future (Perman et al. 2003). Under non use value, we have option value, existence value and bequest value.

Option value is the value an individual attaches to a resource for the sake of future benefits that may be derived from the resource. In other words, the resource may not be producing any benefits now but its capacity to do so in the future is uncertain hence individuals prefer to preserve it rather than do away with the resource (Perman et al. 2003).

Existence value is the satisfaction derived by simply knowing that the resource exists although one may not have any intention of using it. It is the value non users may be willing to pay to keep the resource knowing fully well that they have no aim of using the resource either presently or in the future. In Ghana for instance, a citizen may value the Kakum National Park[3] just for the mere fact that there is one in his home country and it has a canopy walkway even though the individual may be too scared to even use the walkway. Such an individual may be willing to pay something significant to preserve the resource. This individual is said to have an existence value for the Kakum National Park.

Bequest value is the value associated with passing on the resource to future generations. In other words, this value arises from selflessness on the part of current generations and wishing to leave the resource behind for the future generation (Perman et al. 2003).

[3] The Kakum National Park is located in the Central Region of Ghana. It is made up of mostly undisturbed virgin rainforest, enriched with different species of wildlife and has a 40 meter high canopy walkway.

### 3.3.2 Methods for Non Market Valuation

From the literature, methods for valuing non market resources may be generally classified into two – pecuniary and non pecuniary methods. Pecuniary methods are those methods that use money as the numéraire. That is, the monetary value or money equivalent of the goods, services or resources being valued is obtained. Non pecuniary methods on the other hand do not look to assign a money value. They are more general in nature and any value or standard may be used as the numéraire (Mishra, undated)[4]. The pecuniary methods may be grouped into three main categories – Revealed Willingness to Pay, Imputed Willingness to Pay/Circumstantial Evidence and Expressed Willingness to Pay.

#### 3.3.2.1 Revealed Willingness to Pay

In the first category, known as Revealed Willingness to Pay, the methods therein are based on the market price or on consumers' revealed willingness to pay. The main idea here is that if the good, service or resource being valued has a market, then it will have a market price and buyers will reveal their preference for that particular resource by paying for it at the market price. They reveal their willingness to pay by paying what the market price is. Thus the existence of a market price is exploited to assess the value of the resource. Based on this principle, the following valuation methods have been developed: Travel Cost Method (TCM), Averting Behaviour Method (ABM), Market Price Method (MPM), Hedonic Pricing Method (HPM), and Production Function Method (PFM).

[4] Mishra, S. K. (undated) 'Valuation of Environmental Goods and Services: An Institutionalistic Assessment'. Accessed at https://www.msu.edu/user/schmid/mishra.htm

The revealed willingness to pay only measures the use value of a resource and since use value only form a component of the total economic value of a resource, estimates obtained from valuation methods in this class fall short of what the total value of the resource may be.

#### 3.3.2.1.1 The Travel Cost Method (TCM)

This method is often used to value recreational sites and parks. The basic assumption that underpins this method is that if people are willing to incur the costs of travelling to a recreational site and the price of being admitted to the site, then they must value the site that much. It can be noted from how this method works that the value of the resource is drawn from the prices people are willing to pay to access it; that is the cost of transporting oneself to the site and the cost of admission to the site. This way, it is only the use value of the resource that is observed. This is because the inherent values that the users of the site have for the resource is not measured. It is just the cost they pay to use the resource that is measured. Hence, TCM cannot measure the total economic value of a resource.

A major criticism against the TCM is that an individual's decision to visit a site does not only depend on the cost of visiting but also to a large extent, dependent on the time available at the disposal of the individual. That is to say, sampling only visitors to a site to ask about their travel costs and use that as a measure of the value of the resource may be flawed since other people may equally have value for the resource but may have other engagements such as a tight work schedule that do not afford them the time to visit the site for recreation. The values of such individuals may not be counted and this is likely to bias the value given to the resource at the end of the valuation exercise.

Furthermore, it is argued that potential visitors to a recreational site may not be fully informed about the total costs involved and the total benefits they may derive from the site before deciding to visit. Thus for such people, it is difficult to assume that they embarked on the visit because the costs involved indicates their valuation of the resource.

The issue of multipurpose visit is also essential in assessing the validity of value estimates derived from the TCM. A multipurpose trip is the situation whereby an individual embarks on a visit to a particular area for varied reasons. Perhaps work related or family related visits may be combined with a visit to a recreational site – a situation which adversely affects the value attributed to the resource by such a visitor based on his travel costs since he did not incur all those costs merely for the sake of the recreational site.

Since the TCM values only use values and especially because the method has been used to value recreational sites and parks, it may not be suitable for valuing improved electricity supply as is the focus of this study. Typically, people do not travel to go and use electricity and return back to their homes thus making this method less preferred for a study such as this one.

#### 3.3.2.1.2 The Averting Behaviour Method (ABM)

The Averting Behaviour Method (ABM) values a particular resource by looking at the costs of the actions people take to avoid or as the name goes to avert the risks they face should that resource deteriorate in quality. ABM has been typically used to value environmental quality.

The underlying assumption here is that individuals are aware of the adverse effects of deterioration in environmental quality such as air pollution, water pollution, and depletion of the ozone layer among others. Knowing the adverse effects that the deterioration brings, individuals do take certain measures that seek to avert or reduce the risks they face in such environments. The cost of the measures they take is used as a measure of the value of the resource. For example the willingness of people to pay for clean water from a river will be derived from the purchases people make to purify the water to avoid the risks they face because of the polluted water. Another example is when people purchase such goods as sun glasses to avoid the risks they face by walking under the sun due to ozone layer depletion. The costs of these actions are used as a measure of how much they value environmental quality. In the specific case of this study on electricity, an example could be the costs households incur in purchasing items that reduce the adverse effects of poor electricity supply on them such as purchasing a generator.

ABM faces a number of criticisms. A common one is that individuals may value a resource much more than it costs to avert the adverse effects that come with the deterioration of the resource. For example, buying sun glasses may cost far less than the value society places on an undepleted ozone layer. Further, people may purchase a good not because they seek to avert any risk. In the example of the sun glasses, if it becomes fashionable to wear sun glasses, people will make expenditures on it for the sake of fashion and not for the sake of mitigating the effects to the eye of walking under the sun due to ozone layer depletion.

It is further argued that, just because people do not make any expenses to avert the effects of deterioration in environmental quality does not imply they have no value for it. In the case of electricity, the fact that people do not purchase generators to shield them from the adverse effects of frequent power outages does not imply that they do not value continuous supply of power. They may be constrained by other factors for which reason they are unable to make those ‘needed’ purchases. Thus valuing a resource based on information only from those who take certain actions is likely to bias the value given to the resource at the end of the valuation exercise.

The ABM can only be used to determine the value of resources of nature based on certain qualities. Since it does not help in giving the total value of nature because it loses out on non use value, it is not the preferred method for this study.

**3.3.2.1.3 The Market Price Method (MPM)**

This method calculates the total net economic benefit or the total economic surplus of a good and uses that as a measure of value of the good. The higher the economic surplus, the greater is the value of the good or service. Total economic surplus is the sum of the consumer and producer surpluses. Consumer surplus measures the benefits a good or service gives a consumer over and above the cost of acquiring the good. Producer surplus is a measure of the benefits that accrue to a producer over and above the cost of making the good or service available to the consumer.

This method is largely hinged on the market price of the commodity being valued since surpluses are calculated using the market price. However, only a few of environmental goods have markets and hence prices. Therefore, this method cuts off quite a number of non market goods needing valuation. For those goods that have market prices, information asymmetry and other imperfect market conditions do not yield an efficient price and thus arriving at the true economic surplus from these prices is questionable.

Furthermore, in many developing economies, the government takes care of many resources while many inputs are not accounted for in the price of the final commodity probably due to inefficient systems leading to prices that do not fully reflect the worth of the commodity. Again, prices paid by consumers are the going market prices and does not capture their intrinsic value for a resource hence the MPM is not very appropriate for this study.

#### 3.3.2.1.4 The Hedonic Pricing Method (HPM)

The Hedonic Pricing Method (HPM) is often used to value the properties' market and the labour market. In the properties market, it is known as Property Value Approach while in the labour market, it is known as the Wage Differential Approach. The HPM is used to measure non market components or attributes of a marketed good. The HPM relies on the assumption that the price of a good is dependent on the attributes of the good in question and that individuals do value the characteristics that make up a good more than the good by itself. A good may however, have as part of its attributes or characteristics an environmental component which may be difficult to value and the HPM comes in handy to value such non market components of goods.

The HPM measures the value of the separate attributes of a good by looking at how the price of the good changes when the attribute changes. The HPM regresses the price of the good on its attributes yielding a certain function $V = f\ (Y_i s)$.

Where $V$ is the value or price of the marketed good and $Y_i s$ are the attributes of the good. From this function, one can calculate the how the value of the good changes when there is a marginal change in the explanatory variables (the attributes).

HPM assumes weak complementarity and this is a weakness of this method. Weak complementarity here means that for a person who does not use the good or pay for the good, his value of its characteristics is zero which includes the environmental qualities of the good. For a property, this means that HPM will only value the environmental quality of the neighbourhood within which the property is located and not for other places. This method also assesses use values only since it measures environmental changes' effects on price that an individual is willing to pay of the good. It does not measure non use values and hence cannot be used in this study.

**3.3.2.1.5 The Production Function Method (PFM)**

The Production Function Method investigates how environmental qualities affects output levels of an economic activity and from that, gives value to the environment. PFM relies on the fact that some natural resources and environmental quality are inputs in the production process. Thus changes in these resources or environmental qualities will have some impacts on production and the value of the impacts observed through changing market prices. The method essentially measures changes in qualities of nature on production costs and output.

Critics have argued that losses arising from costs of production due to changes in environmental quality may not be very representative of society's value for that environmental quality. In other words, it is one sided because only the producer side is considered without due consideration given to consumer side issues such as consumer surpluses. Furthermore, some producers in the course of production may resort to averting behaviour to reduce the impact of changing environmental quality on their output. This makes it difficult to accurately measure losses in production output as a result of changing environmental quality. For example, a farmer whose land suffers from soil erosion may resort to fertilizers to booster the nutritional needs of the soil in order to avert the soil's inability to sustain high crop yields. The PFM does not capture the total economic value of nature; it captures only a part of total value and thus cannot be used in this study.

### 3.3.2.2 Imputed Willingness to Pay/ Circumstantial Evidence

The second category is known as the Circumstantial Evidence or Imputed Willingness to Pay. Here, the value of a resource is arrived at by finding out people's willingness to pay or the cost of the actions people take to avoid the losses they will incur should the services rendered by the resource be ceased. In the case that the losses do actually occur, the cost of people's actions to replace the losses could also be used as a measure. The idea here is that if people incur costs to avoid damages that arise as a result of lost services provided by non market resources, or to replace them in the event they are totally lost, then the resource must be worth at least the costs incurred to keep or replace them. This is because typically, a rational individual will not pay more money to replace a good or service if the existence of the good or service in question does not yield benefits to him worth the amount he is willing to spend on it. In line with this principle, the following valuation methods have been developed: Damage Cost Avoided Method (DCAM), Replacement Cost Method (RCM), and Substitute Cost Method (SCM) (Mishra, undated).[5]

Circumstantial Evidence Approach is sometimes known as Surrogate Market Valuation Approach. This is because it involves measuring the value of a non market good, service or resource by looking at the market price or shadow price of related goods and services. These related goods and services in this case act as surrogates from which the value of a particular non market good can be inferred.

These related goods or surrogates may either be substitutes to the non market good in question or complements to the good or service a resource may provide or any good from which indirect information about the non market good's changing economic

[5]Mishra, S. K. (undated) 'Valuation of Environmental Goods and Services: An Institutionalistic Assessment'. Accessed at https://www.msu.edu/user/schmid/mishra.htm

impact may be obtained. It is argued that the surrogate market valuation technique is limited by the fact that it is potentially able to provide dependable estimates only if the value of the non market good under consideration is revealed by the prices and behavior of consumers in related markets. Since market prices typically reflect use values of a commodity, what it implies then is that the surrogate market valuation technique is not appropriate if a resource exhibits non use values rather than benefits from use.

#### 3.3.2.2.1 The Substitute Cost Method (SCM)

The Substitute Cost Method (SCM) bases its estimations of the value of a natural resource on the cost of providing a substitute to the resource or the services provided by the resource. An example in Ghana could be the Keta[6] sea defense wall project. This wall was built as a substitute to the ecosystem since the ecosystem had been destroyed and could no longer protect the people of Keta from probable flooding by the sea. The cost of the sea defense project could be used to value the ecosystem under the SCM method of valuation.

#### 3.3.2.2.2 The Replacement Cost Method (RCM)

The Replacement Cost Method (RCM) bases its value of a resource by observing the costs incurred in replacing the resource or the services provided by the resource. Replacement cost is often in terms of the market prices of the resource used as a replacement. For example, if fertilizer is purchased to replace nutrients lost in the soil due to soil erosion, then the costs of the fertilizer in terms of its market price is used to value the soil.

[6] Keta is a town in the Volta Region of Ghana.

### 3.3.2.2.3 The Damage Cost Avoided Method (DCAM)

The Damage Cost Avoided Method (DCAM) bases its value estimates of a resource on the costs of actions that society takes to avoid damages or loses that may occur should the resource cease.

It is argued that the methods in this class –circumstantial evidence- are risky and inaccurate to use. This is because human beings though rational, make some replacement and damage avoidance decisions not entirely out of economic reasons. Sometimes, emotions and feelings guide their decisions. Due to these considerations, damage avoidance or replacement methods of valuation are most appropriate to situations where those damage avoidance or replacement decisions have actually been made or will definitely be made (Mishra, undated).

As earlier stated, these methods are not appropriate for valuing the improved electricity system for this study because among their other flaws, they are unable to intrinsically measure the non use value of nature.

### 3.3.2.3 Expressed Willingness to Pay

The third class of valuation methods is known as the Expressed Willingness to Pay. As has earlier been mentioned, non market goods are not traded in the market place and some if not most of them may not have close semblance with any good or service traded in the market place. Thus 'revealing' ones preference to pay for them is not an option. It is also not always possible to impute people's willingness to pay for a good by observing the costs of their actions taken to avert suffering damages as a result of the loss in the resource. In such cases, people are asked in a survey to state their willingness to pay for a resource after they have been presented with a hypothetical scenario. In other cases, they may be asked to make tradeoffs among different alternatives. Data generated from these surveys are used to estimate people's willingness to pay for the good, service or resource in question.

This class of valuation techniques, also known as stated preference approach involves directly asking individuals what value they attach to unmarketable environmental services, and to express their preferences towards changes in service flows (Lareau and Rae, 1987).

Methods under this category measure both use and non use values of a resource thus giving the total economic value of the good, service or resource being valued. Botchway (2011) cites in his work that because these methods are not tied to behaviour, they can be used to value some goods and services that the revealed preference methods may not be able to value. Valuation methods in this class are the Contingent Valuation Method (CVM) and Contingent Choice Method or the Choice Experiment Method (CEM).

#### 3.3.2.3.1 The Choice Experiment Method (CEM)

Under this valuation technique, WTP is deduced from hypothetical choices or trade – offs that respondents make. Respondents are given a set of alternative representations of a good and are asked to choose their preference. This is similar to real market situations where consumers face two or more goods which possess similar characteristics but at different levels of these characteristics. The respondents are asked to choose whether to buy one of the goods or none of them. In other words, Choice Experiments are a contingent valuation method based on random utility theory and Lancaster's characteristic theory of value which states that, the value of a good is determined by the attributes that make up the whole (Garrod and Willis, 1999).

Choice experiment therefore seeks to find the values for each of these attributes of a particular resource by presenting respondents alternative choices each made of different degrees of the various attributes. Respondents are required to either choose an option or maintain the status quo. The analysis of the trade-offs helps to arrive at the WTP for each attribute.

Choice experiment provides more information about the resource being valued on the whole and the decisions here mirror the decisions faced by consumers in real life where they have options of varying attributes from which to choose.

**3.3.2.3.2 The Contingent Valuation Method (CVM)**

Ciriacy – Wantrup first came out with the Contingent Valuation Method in 1947 as a means of eliciting the market value of a non market good. However, it was first used in a study by Davis (1963). Although this method is tagged as the most controversial of all environmental valuation techniques, it has become the most widely used technique (Hanley et al. 2002).

The CVM measures the value of a resource by calculating the WTP of local residents to keep the resource or the amount required to compensate them for deterioration or a total loss of the resource. In effect, this method asks people to directly state their WTP for a particular good or to improve a particular service or their Willingness -to -Accept (WTA) to give up a good or for deterioration in a service. In other words, this approach involves asking individuals directly the value they attach to a particular resource and/or its characteristics. Thus, the method is able to estimate the respondent's consumer surplus for the resource and therefore the maximum amount the resource is worth to the respondent.

In this technique, a hypothetical scenario which details out the attributes of a certain resource and its effects is created and respondents are asked in a survey how much they (or their household) will be able to pay for that resource or how much compensation they will accept should the resource deteriorate or be lost completely. This technique is called Contingent Valuation because people are asked to state their WTP based or contingent upon a specific hypothetical scenario and description of the resource. The total value of the resource is determined by averaging respondents' values and extrapolating it across the population. This is an open ended contingent valuation format. It has been argued, however, that respondents often find it a difficult task to assign an appropriate value to the resource on their own. This often leads to a wide range of responses in a survey. In contrast to the open ended format is the close ended format of contingent valuation. This is a discrete or dichotomous choice question where respondents are presented with a value and are asked to either respond 'yes' if they would pay that amount or 'no' if otherwise. This typically mirrors the choice of consumers face in an actual market for a commodity where the good has a price and they either buy the commodity at the going price (yes) or they don't (no).

Other elicitation techniques exist. The choice of an elicitation technique however, depends on the type of resource being valued and the nature of the sample. Among the common elicitation techniques are:

- **The bidding game format:** The bidding game was first used by Davis in the early 1960s. This elicitation technique involves taking the respondent through a series of bids until a negative response is generated and a threshold established. There is a starting bid given by the interviewer to which the respondent either agrees to pay (or accept) or disagrees. The interviewer keeps increasing the bid till the respondent answers 'no' to it or keeps decreasing the bid till the respondent answers 'yes' to it. The latest bid to be accepted represents the respondent's maximum WTP (or minimum WTA). There is a starting point bias in this technique. The situation whereby the starting bid suggested by the interviewer has the potential to ultimately influence the respondent's final bid is what is termed as a starting point bias.

- **The payment card format:** This format was developed by Carson and Mitchell (1981 and 1984) as an alternative to the bidding game. This format asks respondents to choose from a range of values which best suits their maximum WTP. This approach doesn't provide a single starting point and thus eliminates the starting point bias as found in the bidding game. However, biases may arise as a result of the ranges used on the cards.

- **The discrete choice format:** The discrete or dichotomous choice format is what may be known also as the take-it-or-leave-it format or the referendum format developed by Bishop and Heberlein in 1979. This approach asks the respondent to either agree or disagree to an amount stated by the interviewer. The amounts given are varied across the sample. This is what most consumers face in actual markets and hence, are familiar with this system. This is also called the single bounded dichotomous choice. This method makes the respondents' task easier similar to the bidding game but this excludes the iterative process component of the bidding game. As noted by Botchway

(2011), the disadvantage with this method is that more observations are required for the same level of statistical exactness in a sample estimate.

- **The discrete choice with a follow up approach:** This approach requires respondents to answer 'yes' or 'no' to an amount regarding their preparedness to pay for a particular resource. A 'yes' response draws out a follow up question with a higher amount while a 'no' response attracts a follow up question with a lower amount this time round. This approach though gives the survey process significant gain in efficiency, still has the limitations observed under the discrete choice technique. After all, this is just the same as the discrete choice; only with follow up questions. Additionally, the follow up questions gives this format some semblance with the bidding game and thus suffers from the limitations of the bidding game especially the starting point bias.

The approach to be employed in this follows the discrete choice with a follow up approach.

Some of the biases that are likely to confront the use of CVM as a valuation technique are discussed below.

- **Starting point bias:** The starting point bias arises when the starting bid given by the interviewer goes to ultimately influence the final response given by the respondent. This bias is best minimized by varying the starting bid among the sample. This way, the interviewer is able to investigate the influence of the starting bids on the final WTP.

- **Strategic bias:** This bias arises when respondents deliberately understate their WTP or overstate their WTA. Sometimes also, WTP may be overstated especially if the respondents are aware that they will not be asked to pay for the resource but their responses are merely being used to get a value for the resource after which the government will provide the good. Respondents are likely to overstate their WTP if they want the good provided or may understate it if they do not want the resource provided. A discrete choice format where 'yes' or 'no' responses are required for differing amounts within the sample may minimize this bias.

- **Hypothetical bias:** Hypothetical bias results from a poor understanding of the hypothetical scenario created from which WTP questions are asked. If respondents misunderstand the scenario or the scenario is misrepresented by the interviewer, it will lead to responses that do not match the hypothetical scenario hence biases. This can be minimized by well explaining the hypothetical scenario and avoiding any ambiguity whatsoever. Hypothetical bias may also arise because people may respond differently to hypothetical decisions compared to how they make actual decisions.

- **Interview and Compliance bias:** Interview bias arises from the conduct of interviewers that tend to influence the responses given by the respondents in a survey. Compliance bias arises when respondents attempt to give answers that they think may please the interviewer. These biases can be minimized by training interviewers well to adhere to the principles of conducting an effective survey.

- **Non response bias:** Non response bias results from the fact that some sample members do not respond and yet they have values for the resource which may be different from those given by respondents. This has the tendency to bias the overall value placed on the resource.

- **Information bias:** Information bias arises because respondents may be asked to value attributes for which they have little or no knowledge of. This means that the information that they are given to the respondents will have substantial influence on their responses.

Despite the likely biases that may arise when the CVM is employed, there are effective ways by which to reduce these biases or eliminate them in some cases as have been discussed. This makes it less costly to use the CVM since the potential biases may be dealt with as opposed to the earlier valuation methods discussed whose biases may be difficult to overcome.

One major merit of the CVM over other valuation methods is its ability to measure both use and non-use values. It is able to measure the total economic value of a resource because respondents will consider both the use values as well as non use values of the resource to them before arriving at the maximum amount they are willing to pay for the resource or willing to accept for deterioration in the resource. CVM is also the most widely used because it is widely applicable as Hanley et al. (2002) posited. According to Pearce and Turner (1990), the CVM is the only known technique for finding the value of many non-market benefits especially their non-use values.

The ability of CVM to capture non use values is further confirmed by Li et al. (undated)[7]. Compared to other methods especially revealed preference methods, the CVM has an advantage. It is flexible enough to allow for the creation of hypothetical market scenario. These hypothetical scenarios may go beyond observed market behaviour and thus helps to measure existence values that are not related to the consumption of other goods.

These are the reasons for which the CVM is the valuation method employed in this study.

### 3.3.3 Willingness to Pay (WTP) and Willingness to Accept (WTA)

There are two Hicksian measures of utility change developed by Hicks (1941) which can be used to study the value attributed to a good or service in a contingent valuation survey – compensating variation and equivalent variation. Compensating Variation is the change in income that would 'compensate' for a price change. It is the maximum amount that an individual would give up for a good or service to keep his utility constant. Equivalent Variation is the change in income that will be 'equivalent' to a proposed price change. It is the minimum amount an individual would accept to forego a good or service or lose some part of the good. This information has been detailed in Table 3.1.

[7] Li, C. J. Löfgren, K. G. and Hanemann, W. M. (undated) 'Real versus Hypothetical Willingness to Accept: The Bishop and Heberlein Model Revisited'. Accessed at http://www.nek.uu.se/StaffPages/Publ/P654.pdf

**Table 3.1 Hicksian monetary measures for the effects of a price change**

| Price Change | Compensating Variation | Equivalent Variation |
|---|---|---|
| Price fall | Willingness to pay for the change occurring | Willingness to accept compensation for the change not occurring |
| Price rise | Willingness to accept compensation for the change occurring | Willingness to pay for the change not occurring |

Source: Perman et al. 2003

Willingness to pay and willingness to accept may provide different values for the same commodity change. WTP for a good is usually lower than WTA compensation to forego the same good (Bishop and Heberlein, 1979) and most studies have also suggested that people tend to value losses more highly than corresponding gains.

It is often difficult to measure WTA accurately in contingent valuation. Bishop and Heberlein (1979) and Bishop et al (1983) substantiate this by reporting in their studies that WTA compensation in contingent valuation surveys exceed actual WTA compensation for the same goods. Due to this, researchers have almost always focused on WTP in assessing the value of a resource.

## 3.4 Empirical Review

Literature on the use of valuation techniques abound. A variety of public programs and other environmental issues have been valued making use of these techniques. The Contingency Valuation Method has been widely used as a technique for valuation in developed countries and more recently in developing countries as well. Studies to assess willingness to pay in areas such as water supply, health insurance, and environmental quality are numerous. However, those that concentrate on assessing the cost of power outages are limited.

This section will review works on willingness to pay to avoid outages or improve electricity as well as WTP on water services. Water related works were reviewed because like electricity, water is also a public utility in Ghana and lessons may be drawn for the electricity sector from the results of water related works especially since quite a number of water services related studies have been conducted both within and without Ghana.

### 3.4.1 Willingness to Pay: Improved Electricity and Avoiding Power Outage Costs

Serra and Fierro (1997) conducted a study on outage costs to Chile's industrial sector. They identified three components of net outage costs: rationing cost, disruptive cost and surplus losses. Their focus was on surplus losses. Interviewing a sample of 200 firms under different classifications giving respondents nine different outage scenarios, the study reported that for a 10% restriction of electricity in a month, outage costs were between US$ 0.5 and US$ 83.5 with the lower costs applying to firms with back up facilities. Different costs were recorded for the different outage scenarios. It was revealed that the outage costs are highly dependent on the rationing strategy used.

Carlsson and Martinson (2004) studied Swedish households to investigate their WTP to avoid power outages. It was observed that households are willing to pay more to avoid a power outage the longer the duration of the outage. Another significant determinant identified in the study was whether outages were planned or unplanned. By planned outages, households are notified in advance about an impending power outage;

unplanned outages referring to the opposite. Specifically the authors reported that households were willing to pay 6.30 SEK (Swedish Krona) for a one hour outage as compared to 189.25 SEK for a 24 hour outage for planned outages. For unplanned outages, the figures were 9.39 SEK and 223.01 SEK correspondingly.

Adenikinju (2005) conducted a study into the costs of infrastructure failures in a developing economy with focus on the electricity sector in Nigeria. By using both a survey and the revealed preference approach, the author analyzed the cost of power outages to the business sector of the Nigerian economy. The study reports that the poor supply of electricity in Nigeria has come at great costs to the business sector. These costs include costs of acquiring very expensive back up capacity to cushion firms against the losses arising from power fluctuations. In other cases, some firms had to shut down production at one time or another as a result of power outages. Factors that underlie power outage costs in this study were the frequency and duration of outages as well as the presence of a backup power facility in a firm.

The work of Serra and Fierro (1997) in Chile as well as that of Adenikinju (2005) in Nigeria, though focusing on the business sectors of their respective economies as opposed to the focus of this study –households, make the logical conclusion that poor electricity supply is a cost whether viewed from the perspective of the household of from that of the firm. When both households and firms suffer from poor electricity supply, losses that will accrue to society will be greater because there would be non production and under production of goods and services due to insufficient supply of power (Munasinghe, 1980) and this will adversely affect the national income of the country whose power supply is unstable.

A study to ascertain the willingness of households to pay for securing natural gas used in electricity generation was conducted in Greece by Damigos et al. (2009). The authors employed the CVM in this study. Their study according to the authors was based on the fact that most of Europe's energy especially fossil fuel sources were imported and about 70% of the European Union's gas imports went into power generation. This situation, they said, called for a need to undertake measures that will secure the supply of natural gas so as to ensure a steady supply of electricity. This would come at an extra cost to society for which the authors sought to investigate how much more households were ready pay to secure natural gas supply. The study reported that households were willing to pay a premium of between €4.5 and €12.7 per MWh on their electricity bills. The WTP amounts in total represented a surcharge of 7.1% on electricity bills. It was concluded that security of natural gas for electricity generation was of great value and households were ready to support measures geared towards it.

This study by Damigos et al. (2009) in Greece deserves extra attention. It can be noted that the study focused on the input used in the generation of electricity and not the final product itself. This deviates from other studies on this subject matter that dwelt on the final product – electricity. This may suggest that transmission and distributional problems and inefficiencies must have been reduced to their barest minimum in Greece hence once the input which is natural gas is secured, the supply of electricity would be steady. For other studies however, households were asked their WTP for the final product which includes all processes from acquiring of inputs right through distribution till households have the end product available to them.

Kateregga (2009) used the CVM to elicit outage costs of electric energy consumers in three Ugandan suburbs interviewing a sample of 200 households in these 3 suburbs. Payment cards and open ended questions were asked and the Tobit model was used to explore the effects of socioeconomic factors on responses. The study revealed that estimated WTP means were greater than the medians. This means that although households incurred costs during outages, few of the sampled homes were willing to pay significant amounts to avert the inconveniences that come with power interruptions. The factors that were found significant determinants of the WTP were income, electric energy as the main source of cooking fuel in the household, and substitution costs.

Abdullah and Mariel (2010) conducted a choice experiment valuation study among electrified rural households in Kisumu District, Kenya to estimate the WTP to avoid power outages or blackouts. A mixed logit estimation was applied to identify various socioeconomic and demographic factors that influenced WTP. The study reported that some households in the surveyed district are willing to pay an amount above their monthly bills to improve electricity supply while others are not prepared to pay any more money above the monthly bills they paid at the time.

It was further revealed that the decision of a household to belong to either of the categories depends on factors such as employment status, age, number of years a household has been living in the district under consideration, family size, ownership of a bank account or otherwise among others. The authors further assert in their study that those who are unemployed, older in age or have been living in the area for a longer period will not be ready to pay more than their monthly bills for electricity improvement. However, individuals who own bank accounts, engage in farming activities or have larger family sizes will be willing to pay more to avoid outages.

The findings of Kateregga (2009) that few of the sampled homes were willing to pay significantly to avoid losses from power interruptions partly agrees with the findings of Abdullah and Mariel (2010) that only a part of the sample was ready to pay significant amounts (in this case, amounts above their monthly bills) to avoid costs of power interruptions. In terms of the determining factors, income or employment status as used in the work by Abdullah and Mariel (2010) was seen to be significant in both cases signifying a strong reliance of WTP on a respondent's ability to pay measured by his income level or his employment status.

McNair et al. (2011) investigated households WTP for the conversion of electricity distribution networks from overhead to underground. The authors note in their work that underground low voltage electricity networks are advantageous compared to overhead ones. The benefits of the underground networks include reliability of supply, safety as well as improved visual amenity. However, the value that households place on these benefits will determine whether or not it is economically rational to convert overhead networks to underground ones. The study therefore sought to establish how much households were willing to pay for this conversion (which will stem from how much they value the associated benefits) via a choice survey in residential areas in Canberra, Australia. The study results showed that on the basis of the evidence reported, the value that households place on undergrounding electricity networks (and for that matter, the benefits that come with it such as reliability of supply, safety and visual amenity) was a conservative average of at least A$6,838 per property. The conclusion is that households have some value for the overhead to underground conversion exercise because of the benefits that it will bring them and thus are willing to pay for it.

This paper by McNair et al. (2011) does not necessarily calculate outage costs or focus on improving electricity per se; the paper actually admits that electricity supply is largely reliable in Australia with few power cuts occasionally. However, households chose to pay for undergrounding of electricity networks in order to enjoy its benefits which include more reliable supply (even though supply is quite reliable already). This goes to show that for a good like electricity, households can never have enough of improvement. Once there is room for further improvement, rational economic agents such as households will go for it. Another benefit that undergrounding would offer to Australian nationals is the relaxation of tree trimming responsibilities. This is because in Australia it is the responsibility of residents to ensure that overhead networks, which are reticulated right along the boundaries of their houses, are not interfered by trees. Tree trimming is therefore constantly required of residents in order to keep them from coming close to the electricity networks.

Pepermans (2011) researched on Flemish households in Belgium to ascertain the value of continuous power supply. The study noted that electricity supply is largely reliable in Belgium and as such power outages are quite unlikely. Using the choice experiment approach the author established, however, that on average most household types will be willing to accept as much as €30.00 - €50.00 to have just one additional power outage per year. Additionally, he estimates the average Willingness to accept (WTA) for just a one minute increase in the duration of an outage to be in the region of €0.30 - €0.60 per minute.

In terms of placing monetary values on the costs of erratic power supply, both Carlsson and Martinson (2004) and Pepermans (2011) have the same conclusion. Both studies agree that their respondents were willing to give up significant amounts for power outages or willing to accept significant amounts for the occurrence of power outages. Both studies have as a strong determining factor, the duration of the outage. The findings of these two studies conducted in Sweden and Belgium interestingly deviate slightly from those conducted in African countries (Uganda and Kenya). In terms of WTP in the context of the developed countries, it is neither lost nor even doubtful that households have high WTP to avoid the costs they face when electricity supply is cut. There is no compromise on the value placed on constant flow of electricity by residents of the more developed economies. However, in the African context, the same cannot be said. Not many of the respondents would readily be willing to pay huge amounts of money to avoid losses from power outages.

In terms of significant determining factors, income was a key factor in influencing WTP within the African context whereas within the context of the more advanced economies, the major issue was on the duration of the outage rather than income. This may be due to the fact that in the more developed economies, having continuous supply of electricity is deemed an absolute necessity; not at all an option irrespective of the income or social status of a person. However, in the African setting, having continuous supply of power in every home for most of the African economies would be considered a 'miracle'. This is because having electricity continuously and continually is deemed by most commoners as a luxury; the preserve of high income earners or of the highly respected persons in society. Therefore, WTP for improved electricity in these countries is most likely to be highly dependent on the income levels of the people as Kateregga (2009) and Abdullah and Mariel (2010) rightly posited.

**3.4.2 Willingness to Pay: Improved Water Supply**

Hensher et al. (2005) studied households' willingness to pay for water service attributes in Canberra, Australia. The study used choice experiment and mixed logit models to estimate WTP to avoid interruptions in water service and overflows of wastewater. The study revealed that the reliability of water and wastewater service was of much value to residents such that they were willing to pay to reduce the frequency and duration of disruptions in water supply and of overflows of wastewater. The study found that the number of interruptions a consumer faces per year determines WTP for water supply whiles the frequency of waste water overflows determines WTP to avoid overflows. Other factors that affected WTP in the case for water supply included notification of an interruption, timing of planned service interruptions, and the method of handling customer calls. These attributes were noted to affect customers' willingness to pay to avoid a service interruption.

Vásquez et al. (2009) used a referendum format CVM to elicit households WTP for safe and reliable drinking water in Parral, Mexico. It was noted that prior to the study, households had resorted to averting and private choices such as buying bottled water or engaging in home based water treatment to deal with the existing water supply. These actions revealed a demand for safer and more reliable water service. A CV survey where households would expressly state their WTP was thus conducted as a confirmation of the demand for safer water service. The results indicated that households are willing to pay from 1.8% to 7.55% of reported household incomes above the existing water costs for safe and reliable drinking water.

Botchway (2011) used the CVM and the ordered probit model to investigate households' WTP for improved water supply in the Accra – Tema metropolis, Ghana together with the factors that determine households' WTP. He used a discrete choice with follow-up elicitation technique and reports that households were willing to pay about 10Gp for a bucket of water; an amount which was about seven times the tariff at the time of his study. He identified income, time spent to fetch water from existing source, level of education, sanitation facility, perceived quality of current water supply, sex of the respondent, marital status as the main factors that determines households' willingness to pay for improved water supply services in the metropolis.

The studies on WTP for improvement in water show that society values consistent flow of water and this is evidenced in the fact that households are willing to pay for improvement in water supply. Vásquez et al. (2009) and Botchway (2011) show that households are willing to pay over and above their water rates at the time they conducted their respective surveys to improve electricity. Results from the study by Botchway (2011) confirmed earlier studies on WTP for improved water supply in other areas of Ghana (Adjei, 1999; Appau-Danso, 2004).

It is observed that households in Ghana place high value on water because of the centrality of water in their daily affairs and they are ready to pay for the increased cost of improvement once they can be assured of it. Besides the health benefits of water, hardly will one go through an entire day without using water for other purposes besides drinking. Likewise, with the numerous benefits of electricity to most households as outlined in previous chapters and the varied purposes for which various households demand electricity, it can be rightly predicted households may be willing to pay increased tariffs once it assures steady and reliable supply.

### 3.5 Summary of chapter

The chapter reviewed literature on valuation methods, electricity and WTP to improve it as well as a few works in the water sector. Judging from the studies reviewed above and many others not reported here, the CVM has been shown to be very widely used in estimating the economic values people place on non market goods such as improved electricity and improved water services. From the empirical studies, some of the major factors that have been revealed to determine WTP for such goods as improved electricity supply and improved water services include income, age, education, occupation among others.

This study will therefore use the CVM to estimate the value households in the Accra-Tema metropolitan areas are willing to pay for improvement in electricity supply and investigate the factors that affect their WTP with guidance from the literature as discussed above.

# CHAPTER FOUR

# THEORETICAL FRAMEWORK AND METHODOLOGY

## 4.1 Introduction

This chapter details the methodology adopted in this study. It discusses the theoretical framework underpinning the study, gives an overview of how the survey was conducted and the means by which the responses obtained were analyzed.

## 4.2 Theoretical Framework and Empirical Model

This study adopts the framework of the Random Utility Model pioneered in the 1920s and later modified to incorporate the manner of specifying utilities developed by Lancaster (1966) and McFadden (1974). As employed by Walker and Ben-Akiva (2002) and Botchway (2011), this study assumes a utility function after the Random Utility Model (RUM) in which utility provided to individual *i* by good *j* ($U_{ij}$) is a function of observed characteristics of the individual and of the good being consumed as well as a function of an unobserved stochastic error term $e_{ij}$. The indirect utility function associated with this kind of utility function may be written as

$$U_{ij} = U_i\,(Y_j, X_j, e_{ij}) \quad \ldots\ldots\ldots\ldots \quad (4.1)$$

Where $Y_j$ is disposable income for household j, $X_j$ is the vector of observed characteristics of the household and of the given choice of the household, and $e_{ij}$ is the unobserved error term of the indirect utility function.

A payment bid $Y_i$* is introduced which changes the characteristics of the (environmental) good in a contingent valuation survey such as the quality of the good. The consumer will agree to the payment proposed if and only if the utility derived from the improved state is greater than the utility derived from the status quo. Symbolically, if

$$U_{ij}\,(Y_j - Y_i^*, X_j, e_{ij}) > U_{ij}\,(Y_j, X_j, e_{ij}) \quad \ldots\ldots\ldots\ldots \quad (4.2)$$

Where $Y_i$ * is the amount the respondent is willing to pay for the proposed improvement in the resource. The probability that a respondent will answer yes is an indication that he prefers the proposed improvement. Thus for the jth respondent, the probability that he answers 'yes' is given by

$$\Pr(\text{yes}) = U_{1j}\,(Y_j - Y_i^{*}, X_j, e_{ij}) > U_{0j}\,(Y_j, X_j, e_{ij}) \quad \ldots\ldots\ldots \quad (4.3)$$

According to Cameron and Trivedi (2005), a common formulation of the Random Utility Model (RUM) is the Additive Random Utility Model (ARUM). The ARUM assumes that the utility function is additively separable into deterministic and stochastic preferences. Thus equation 4.1 may be written as

$$U_{ij} = U_i\,(Y_j, X_j) + e_{ij} \quad \ldots\ldots\ldots\ldots\ldots \quad (4.4)$$

The probability statement that a respondent answers 'yes' to a proposed bid therefore becomes

$$\Pr(\text{yes}) = U_{1j}\,(Y_j - Y_i^{*}, X_j) + e_{1j} > U_{0j}\,(Y_j, X_j) + e_{0j} \quad \ldots.. \quad (4.5)$$

Now let $WTP_i$ be the maximum amount a household is willing to pay for improvement in electricity supply. From consumer demand theory, $WTP_i$ is hypothesized to be a function of the household's socioeconomic attributes and the characteristics of the electricity supply (Greene, 2008). Furthermore, since utility in the RUM depends on deterministic and random components, the change in utility associated with an improvement in electricity supply will equal the change in the deterministic and random components. In other words, WTP can be written without loss of generality as:

$$WTP_i = \beta_i X'_i + e_i \quad \ldots\ldots\ldots\ldots\ldots\ldots. \quad (4.6)$$

Where, $\beta_i$ is the vector of estimated parameters, $X_i$ is a vector of the household's socioeconomic attributes and the characteristics of electricity supply and $e_i$ the error term which captures all other factors that affect households' WTP which have not been included in the model. The error term is assumed to follow a standard normal distribution with a mean of zero and variance of one. On the basis of this framework, this study estimates the following equation:

$$WTP_{i} = \beta_1 CCEL_i + \beta_2 IB_i + \beta_3 SEX_i + \beta_4 HSIZi + \beta_5 HINC_i + \beta_6 BEDU_i + \beta_7 SEDU_i + \beta_8 TEDU + \beta_9 REL_i + \beta_{10} PRNTF_i + \varepsilon_i \quad \ldots\ldots\ldots (4.7)$$

Where:

WTP= Maximum Willingness to Pay

CCEL= Current Monthly Cost of Electricity

IB= Initial Bid

SEX= Sex of Respondent

HISZ= Household Size

HINC= Household Monthly Income

EDU= Highest Educational Level Attained by Respondent

(BEDU= Basic Education; SEDU= Secondary Education; TEDU= Tertiary Education)

REL= Reliability of Current Supply

PRNTF= Prior Notification Given Before Current Outages.

### 4.2.1 Description of Explanatory Variables

**Current Monthly Cost of Electricity (CCEL)**

CCEL is a measure of the average amount of money that households currently spend on electricity monthly. It is a continuous variable. An ambiguous relationship is expected between this variable and WTP. This is because on the one hand, some households who pay high amounts for electricity may not be willing to pay any more because they consider the amounts they pay as high already while households who pay lower amounts may be willing to increase the amounts they pay for improved electricity. On the other hand, other households who pay high amounts for electricity perhaps do so because of the extent to which they need the service. Such people may be willing to pay even higher if and only if it will lead to improvement in the service delivery while those households who pay lower amounts because they barely use the service may not be willing to pay any higher amounts to improve the service because they hardly make use of it in their homes.

**Initial Bid (IB)**

The initial bid is included as an explanatory variable to determine whether households' responses were influenced by the starting bid given by the interviewer. It is a continuous variable and its sign will be known in the course of the study.

**Sex of Respondent (SEX)**

Sex is a dummy variable with 1 representing male and 0 representing female. Although typically, males are usually the controllers of households' finances and are in the position to determine how much they may want to pay for improved services, some households are also headed by females or have females who are gainfully employed and therefore contribute significantly to the disbursement of household resources. The impact of gender on WTP is therefore uncertain. Besides, both males and females alike share in the benefits of electricity. Some WTP studies especially those conducted in developing economies such as studies by Mensah (2011), Bothchway (2011), Aguilar and Sterner (1995) have revealed the significance of gender in determining WTP for the commodities they measured. The sign gender carried, however, differed in these studies leading this study to have an ambiguous expectation of the sign of sex in this study.

**Household Size (HSIZ)**

Household size, a continuous variable, is a measure of the number of individuals in a household. The influence of the household's size on WTP is indeterminate. This is because, on the one hand, households with larger numbers will have more people benefiting from the use of electricity for varying uses. As such, the absence of improved electricity will cost this household greatly and thus such a household will be willing to pay more for improved electricity. On the other hand, a household with large numbers is likely to incur huge expenditures in caring for the needs of the members of the household especially if a good number of them are unemployed. Such a household may not be willing to pay any higher for improved electricity supply.

**Household Monthly Income (HINC)**

Household income is a continuous variable and is a sum of the monthly incomes of all earners in the household. This measure is preferred to just the income of the household head because electricity supply to a household is a service enjoyed by all members of the household. Thus if improving the service to the household will cost more than the household head can afford, other earners in the household may be willing to contribute some amounts of money so that the household will be able to pay for the improved service to the end that they all benefit from the improvement in electricity supply. It is known from consumer demand theory that a normal good has a positive relationship with the consumer's income. Electricity is a necessity but electricity of a better and higher quality will be demanded as the consumer's income increases and thus increasing his ability to pay. Additionally, earlier empirical studies (Kateregga, 2009;

Abdallah and Mariel, 2010; Mensah, 2011) have revealed a positive relationship between income and WTP. Thus, a positive relationship is expected between WTP and household income.

**Highest Educational Level of Respondent (EDU)**

Households whose heads have higher education may value improved electricity more since electricity is also a measure of development. Such households are expected to have a higher WTP for improved electricity than households whose heads have lower levels of education. A positive relationship is therefore expected. Education is a categorical variable with No Formal Education being 0, Basic Education (BEDU) being 1, Secondary Education (SEDU) being 2 and Tertiary Education (TEDU) being 3. Households whose heads have no formal education will be used as the reference point against which the impact of other levels of education will be studied.

**Reliability of Current Supply (REL)**

Households who perceive the current supply to be unreliable will be willing to pay more to improve it as opposed to households who deem the current supply reliable. Reliability is a dummy variable with reliable represented by 1 and unreliable represented by 0. A negative relationship is therefore expected.

**Prior Notification Given Before Current Outages (PRNTF)**

Households who are given prior notification before an outage are likely to suffer fewer losses than those who experience sudden power outages. Hence those who are notified ahead of an outage are likely to have a lower WTP for improved services since the improved state involves consumers being notified well in time ahead of a planned outage. Households who do not receive prior notification are likely to pay more for improvement in electricity supply. Carlsson and Martinson (2004) have shown that WTP to avoid a planned outage (which comes with prior notification) is lower than WTP to avoid an unplanned outage (which does not have the benefit of prior notification). Prior notification is a dummy variable with prior notification given before an outage represented by 1 and no notification given represented by 0. A negative relationship is expected between WTP and prior notification given before an outage.Table 4.1 shows a summary of the explanatory variables, their classifications and signs they are expected to carry.

**Table 4.1: Classification of explanatory variables and their expected signs.**

| Variable | Classification | Expected Sign |
|---|---|---|
| Current Cost of Electricity (CCEL) | Continuous | +/- |
| Initial Bid (IB) | Continuous | +/- |
| Sex of Respondent (SEX)<br>(Male=1; Female=0) | Dummy | +/- |
| Household Size (HSIZ) | Continuous | +/- |
| Household Monthly Income (HINC) | Continuous | + |
| Highest Educational Level of Respondent (EDUC)<br>(NEDU=0; BEDU=1; SEDU=2; TEDU=3) | Categorical | + |
| Reliability of Current Supply (REL) (Reliable=1; Not Reliable=0) | Dummy | - |
| Prior Notification Given Before Current Outages (PRNTF)<br>(Prior Notice Given=1; No Prior Notice Given=0) | Dummy | - |

Source: Author's Survey, 2013

### 4.3 Data Types and Sources

Data for this study was sourced mainly from primary sources within the study area. Pieces of information were obtained from secondary sources particularly the report of the Ghana Living Standards Survey 5 (GLSS V) and the 2010 Population and Housing Census report both by the Ghana Statistical Service (GSS) to aid the sampling of households for interviewing and to aid in the analysis of the data.

#### 4.3.1 Survey Instrument

The main instrument for the data collection was a questionnaire. A well structured questionnaire was administered to a sample of households within the Accra-Tema metropolis via face-to-face interviews. A hypothetical scenario of an improved electricity supply system was created. In this scenario, power supply was assumed to be reliable and of good quality. Reliability means the power supply is available every time and good quality means the power supply comes with the appropriate level of voltage. The hypothetical case rules out power outages to a large extent. Power outages may only occur when repair works need to be carried out and even in such cases, users of electricity who will be affected would be notified ahead of the outages and the outage will not last beyond two hours. Respondents were then asked to state the maximum amount they are willing to pay for such an improved electricity supply system.

#### 4.3.2 Pilot Survey and Training

Like most surveys, inaccurate responses are likely to be given by respondents and the CVM is no exception. To increase the accuracy and validity of the responses given in the contingent valuation survey, it is imperative for the researcher to create reasonable and practical scenarios which the respondents can identify with and have been appropriately priced. In line with this, a pilot study was conducted prior to the main survey. The selected sample areas were visited by the researcher to meet with some residents in the area. The interactions with the residents gave the researcher an understanding of the current electricity supply conditions. A mock questionnaire was designed and the respondents were asked to answer the questions to the best of their knowledge. Feedback from the pilot survey was used to review and redesign the questionnaire for the actual survey.

Like any other survey, biases are likely to arise right from the design of the survey, administration of questionnaires, creation of the hypothetical scenario and application of the elicitation technique among others. These biases may ultimately show up in the responses by the respondents. Effective training for interviewers and the appropriate 'know how' may help to reduce biases to the barest minimum. Enumerators who were undergraduate students selected from the Department of Economics, University of Ghana were therefore trained prior to the administration of the questionnaires.

The training focused on getting enumerators to understand the hypothetical scenario in order to be able to communicate it well to the respondents to avoid hypothetical bias. Respondents were also instructed on what degree of information would be adequate for each question. The training course was also used to teach enumerators best practices during the conduct of interviews in order to avoid interview and/or compliance biases. Interviewers were taught how to probe and reduce strategic behavior without imposing their own responses on the respondents.

### 4.3.3 Sampling Frame

The survey was carried out within the Accra – Tema metropolis in the Greater Accra Region of Ghana. Households in both urban and rural towns in the metropolis were sampled. Sampling of respondents in the selected towns was done systematically. The sampling units were made up of households with electricity. A total of 384 households were interviewed from six suburbs in the Accra- Tema metropolis. However, a few questionnaires showed varying degrees of inconsistencies in their responses and were thus dropped. A total of 358 questionnaires were the valid ones used for the analysis. Rural – urban considerations were made in this study in order for the data to fairly represent residents living in different sections of the metropolis. According to the Ghana Statistical Service (GSS), a rural community is one which has not more than five thousand inhabitants. A list of all rural suburbs within the metropolis as per the 2010 population and housing census was obtained from the GSS. From this list, three suburbs which fall within the upper range of between 4000 and 5000 residents were sampled to be interviewed. Suburbs within this upper band were chosen because these suburbs have more residents than the other rural suburbs and therefore a much wider spread of households with more even characteristics is expected in these suburbs than rural suburbs with fewer residents. Of the 358 questionnaires, a total of 176 questionnaires were administered in the three rural suburbs representing 49.1% of the total questionnaires and the remaining 182 representing 50.9% were administered in three urban suburbs. This agrees with the GSS's estimation that 49.1% of the country's population live in rural localities while the remaining 50.9% live in urban localities.

#### 4.3.4 Questionnaire Design and Elicitation Format

Following the recommendations of the National Oceanic and Atmospheric Administration (NOAA) in 1993, the CV questionnaire was designed to focus on precision and clarity of the hypothetical scenario. The report of the NOAA also recommended that WTP should be about a future event and not one that had already occurred. Additionally, the interview should be conducted in person (face-to-face). The questionnaire was therefore designed to meet these standards. The questionnaire was specific and precise about the benefits or improved attributes of the proposed improvement in electricity supply for which respondents were being asked their WTP. The questionnaire included questions about characteristics of the existing electricity supply system, households WTP and the socioeconomic characteristics of the respondent and his/her household.

The elicitation format employed in this study was the discrete choice with a follow-up approach. Here, an initial bid was given to each respondent. If the respondent agreed to pay that amount, a higher amount was proposed. If he agreed to that, a third amount, higher than the second was further proposed. If he declined to pay the initial bid, the follow up bid proposed to the respondent is lower. After going through the follow up process, all respondents were asked to state after careful thoughts what their maximum WTP for the improved electricity supply would be. The amounts each respondent stated here were compared to the responses from the follow up process to check for consistency. This format was chosen due to the advantages it has over other applicable formats as previously discussed in this work.

A likely bias associated with this format is the starting bid bias. To help correct for this bias, the initial bids given were varied among the sample. Six initial bids were used in this survey. Feedback from the pilot study informed the initial bids used in the survey.

### 4.3.5 Field Work

Field operations started in the first week of January and continued for four weeks. In each town, the interviewer identified households who fell within the sample frame and the sampling design chosen. The purpose of the survey was explained to the household head or his representative following which the interview was conducted. The answered questionnaires were reviewed for accuracy and consistency.

#### 4.3.6 Description of the Study Area

The Accra-Tema metropolitan area is located in the Greater Accra Region of Ghana. The population of the metropolis is 2,251,251 making up 56.1% of the total population in the region and 9.2% of the total population of the country (GSS, 2012). The metropolis is home to varied commercial and industrial activities; manufacturing, trading, services and other economic activities take place on a large scale within Accra-Tema. The Tema metropolis in particular is notable for the location of major factories in Ghana including the Tema Oil Refinery, Tema Lube Oil, Cocoa Processing Company, Nestle Ghana Ltd. and a host of others. A port is also located in this metropolis which serves not only the needs of the country but those of neighbouring land locked countries such as Burkina Faso and Mali. These make the Accra-Tema metropolis a very important metropolis in Ghana and indispensable to the nation's productivity.

### 4.4 Data Analysis and Estimation Techniques

#### 4.4.1. Contingency Valuation Method

Several valuation techniques have been used to measure non market commodities. These include the travel cost method, choice experiment, among others. In this study, the Contingent Valuation Method (CVM) was used to obtain the willingness of households to pay for improved electricity supply. This technique is appropriate for this study because how much a consumer is willing to pay to avoid power outages invariably depict the cost to households of these outages. Additionally, the method allows us to assess both use and non – use value compared to other methods like Travel Cost which assess only use values.

A survey in the study area was conducted and household heads or their representatives were asked questions about their existing electricity supply and other socioeconomic characteristics of the respondents and their households. A hypothetical scenario of an improved electricity supply system was created. Based on this scenario, respondents were asked to state the maximum amount they will be willing to pay per kilowatt hour of electricity for the proposed improvement.

### 4.4.2 The Ordered Probit Model

The Ordered Probit Model was employed as the main estimation technique for the study. The ordered probit was preferred in this study because although households may give an amount as their WTP, it may not be their maximum WTP. Their true WTP may lie within a certain interval of the maximum value the respondent is willing to pay and the next highest value. (Maddala, 1983; Greene, 2008).

This implies that although the outcome of the event is discrete, the multinomial logit or probit model would fail to account for the ordinal nature of the response variable. The ordered probit model has merits over the unordered multinomial conditional or nested logit or probit model in that while accounting for the nature of the dependent variable, the unordered multinomial probit and logit models fail to account for the ordinal attribute of the dependent variable (Botchway, 2011). Linear regression model is also not an appropriate procedure for dealing with such an ordinal dependent variable because the assumptions regarding the specification of the error term in the linear model will be violated (Maddala, 1983). The ordered probit is also preferred to linear regression model because it accounts for unequal differences between the ordinal categories in the dependent variable (Greene, 2008). The ordered probit model is specified as follows:

$$WTP_i = \beta_i X'_i + e_i \qquad \ldots\ldots \qquad (4.8)$$

$WTP_i$ is unobserved, however, we would know the ranges within which $WTP_i$ falls from the responses. Let $R_1$, $R_2$, ……, $R_J$ be the j prices which divide the range of WTP space into J+1 categories and $WTP_i$ be a categorical variable such that:

$$WTP_i = \begin{cases} 1 & \text{if} \quad WTP_i^* \leq R_1 \\ 2 & \text{if} \quad R_1 < WTP_i^* \leq R_2 \\ 3 & \text{if} \quad R_2 < WTP_i^* \leq R_3 \\ . & \\ . & \\ J+1 & \text{if} \quad R_J < WTP_i^* \end{cases} \qquad \ldots\ldots\ (4.9)$$

If j=1, 2,…, J+1, then the $WTP_i^* = j$ if

$$\begin{aligned} R_{j-1} &< WTP_i^* \leq R_j \\ \text{or } R_{j-1} &< \alpha + X_i'\beta + \varepsilon_i \leq R_j \\ \text{or } R_{j-1} - \alpha &< X_i'\beta + \varepsilon_i \leq R_j - \alpha \\ \text{or } R_{j-1} - \alpha - X_i'\beta &< \varepsilon_i \leq R_j - \alpha - X_i'\beta \end{aligned} \qquad \ldots\ldots\ldots\ldots\ (4.10)$$

The WTP values obtained from the survey would be used as the dependent variable in the regression. This is because, although $WTP_i^*$ is unobserved, we can determine the exact category of WTP households belong to since they would indicate the amount they would be willing to pay for improved electricity supply. From the above discussions, the probability that household *i will* choose category *j* is given by:

$$\begin{aligned} \Pr\left[WTP_i = j\right] &= \Pr\left[R_{j-1} < WTP_j \leq R_j\right] \\ &= \Pr\left[R_{j-1} < \alpha + X_i'\beta + \varepsilon_i \leq R_j\right] \\ &= \Pr\left[R_{j-1} - \alpha - X_i'\beta < \varepsilon_i \leq R_j - \alpha - X_i'\beta\right] \ldots\ldots\ (4.11) \\ &= \Pr\left[u_{j-1} - X_i'\beta < \varepsilon_i \leq u_j - X_i'\beta\right] \\ &= \Phi\left[u_j - X_i'\beta\right] - \Phi\left[u_{j-1} - X_i'\beta\right] \end{aligned}$$

Where $u_j = R_j - \alpha$

Given J+1 WTP categories, the probability of a household $i$ choosing a category *j* (where j=1, 2, 3,……, J+1) is given by:

$P_i(1) = Pr(WTP_i = 1) = Pr(WTP_i^* \leq R_1) = Pr(X_i'\beta + e_i \leq u_1) = Pr(e_i \leq u_i - X_i'\beta) = \Phi(u_1 - X_i'\beta)$

$P_i(2) = Pr(WTP_i = 2) = Pr(R_1 < WTP_i^* \leq R_2) = Pr(e_i \leq u_2 - X_i'\beta) - Pr(e_i \leq u_1 - X_i'\beta)$

$= \Phi(u_2 - X_i'\beta) - \Phi(u_1 - X_1'\beta)$

:

:

$P_i(J) = Pr(WTP_i = J) = Pr(R_{J-1} < WTP_i^* \leq R_J) = \Phi(u_J - X_i'\beta) - \Phi(u_{J-1} - X_i'\beta)$

$P_i(J+1) = Pr(WTP_i = J+1) = Pr(WTP_i^* > R_J) = 1 - \Phi(u_J - X_i'\beta)$ (Woodridge, 2010)

Where $u_j$'s are the threshold parameters which will be estimated as well as the coefficient vector β. The cumulative standard normal distribution is given by Φ [.] (Greene, 2008).

The threshold parameters are the cut off points where a respondent's WTP moves from one category to the next. The βs and the threshold parameters may be obtained by maximizing the log likelihood function:

$\ln L = 1[WTP_i = 1] \ln[\Phi(u_1 - X_1'\beta)] + 1[WTP_i = 2] \ln[\Phi(u_2 - X_1'\beta) - \Phi(u_1 - X_1'\beta)] + \ldots\ldots + 1[WTP_i = j] \ln[\Phi(u_j - X_1'\beta) - \Phi(u_j\text{-}1 - X_i'\beta)] + \ldots + 1[WTP_i = J+1] \ln[1 - \Phi(u_J - X_i'\beta)]$ (4.12)

When the above equation is simplified, it yields

$$Ln\ L = \sum \sum WTP_{ij} \ln[\Phi(u_j - X_i'\beta) - \Phi(u_{j-1} - X_i'\beta)] \quad \ldots\ldots\ (4.12)$$

In using models such as the ordered probit, interpreting the parameters from the regression is of little importance. According to Woodridge (2010), the response probability does not matter much because WTP is unobserved. Meaningful conclusions can be made if the marginal effects are estimated. The marginal effects show the how the probability of each outcome changes as a result of changes in the regressors. The marginal effects for the categories are given by:

$$\partial \Pr(WTP_i = 1 | X) / \partial X_i = -\phi\,(u_1 - X_i'\beta)\,\beta$$

$$\partial \Pr(WTP_i = 2 | X) / \partial X_i = [\phi\,(u_1 - X_i'\beta) - \phi\,(u_2 - X_i'\beta)]\,\beta$$

:

:

$$\partial \Pr(WTP_i = J | X) / \partial X_i = [\phi\,(u_{J-1} - X_i'\beta) - \phi\,(u_J - X_i'\beta)]\,\beta$$

$$\partial \Pr(WTP_i = J+1 | X) / \partial X_i = \phi\,(u_J - X_i'\beta)]\,\beta$$

Where $\phi(.)$ is the derivative of $\Phi[.]$

In the ordered probit model, the signs of the 'internal' marginal effects are unknown and cannot be determined by the signs of the estimated coefficients ($\beta$s) in the regression. Only the signs of the marginal effects of the lowest and highest categories may be known by observing the signs of their coefficients in the ordered probit regression. Thus only the marginal effects of Pr ($WTP_i$=1 |X) and that of Pr ($WTP_i$=J+1|X) may be known readily. The signs of the marginal effects of the other categories may differ from the signs of the $\beta$s.

# CHAPTER FIVE

# ANALYSIS AND DISCUSSION OF RESULTS

## 5.1 Introduction

This chapter presents the findings from the study and discusses the empirical results obtained. The first section of this chapter analyses the data via descriptive methods whiles the second section concentrates on the econometric estimation of the data.

## 5.2 Discussion of Results from Questionnaires

This section analyzes the socioeconomic features of the respondents and the existing electricity supply situation as experienced by the households interviewed.

### 5.2.1 Socioeconomic Features of Respondents

The Contingent Valuation Survey interviewed a total number of 358 households from different suburbs within the Accra-Tema metropolis.

Of the total number interviewed, 157 of them were females and 201 were males representing 43.9% and 56.1% respectively. Household size averaged at 4.77 persons per household with a minimum of 1 person and a maximum of 30 persons in a household. The age distribution of the sample was such that 13.4% were below the age of 30years while 29.6% were between the ages of 30years and 39 years inclusive. The modal age category was 40years to 49years inclusive representing 30.2% of the respondents. About 20% were between the ages of 50years to 59years inclusive with the senior citizens aged 60years and above representing 7.3% of the sample. This is shown in Figure 5.1

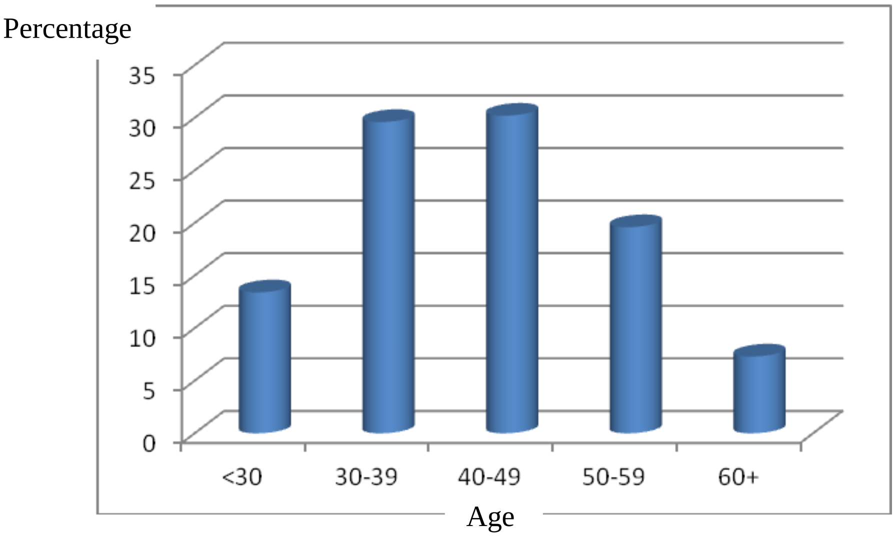


**Figure 5.1 Age distribution of the sample**

Source: Author's Survey, 2013.

Respondents were asked their highest level of education attained and it was revealed that 5% of the sample had no formal education while 23.2% had attained up to basic education. The percentage that had attained up to secondary education was 34.9% while 36.9% of the sample had attained tertiary education. This is presented in Figure 5.2. It is not surprising that over 71% of the sample had attained at least secondary education. This is because the study area is in the Greater Accra Region which has the highest population of 15 years and older who have attained up to secondary and tertiary education among all the regions in the country (GSS, 2012).

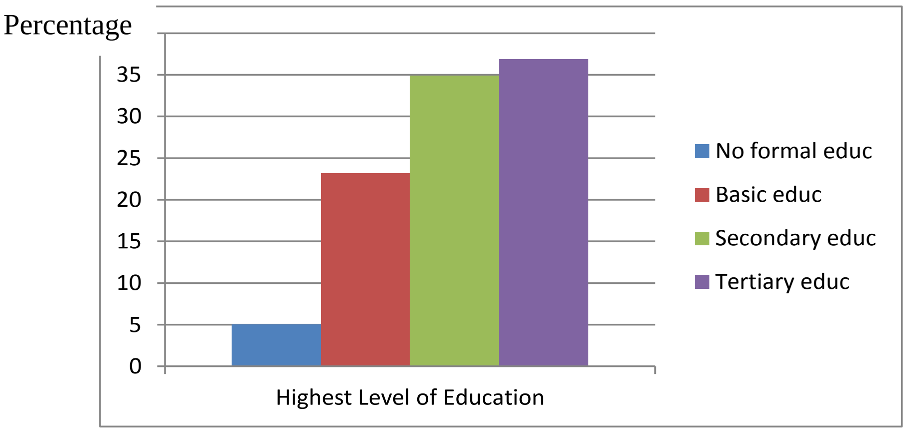


**Figure 5.2 Educational distribution of the sample**

Source: Author's Survey, 2013.

The study sought to know what occupations respondents were engaged in. The occupations of respondents were placed into various categories to avoid the complexities that may arise from attempting to analyze separately the individual occupations of each respondent. The categorization was done as follows. Artisans were placed in category 1. This category includes all persons involved in such occupations as tailoring, hairdressing/barbering, artists, mechanics, and the like. Category 2 workers were those involved in agriculture. This includes farmers (both plant and animal) and fisher folk. Those classified under category 3 are those persons employed in the public service or in the civil service. This is basically made up of all employees on government payroll. Category 4 workers are those employed in the private sector. This includes the private banks, the telecommunication industry, insurance companies, and all employees who are not on the payroll of the government. Category 5 workers were businessmen/businesswomen. This category is mainly made of persons who are engaged in trade. Category 6 takes care of all other occupations that fall outside the range of the five stated categories. This categorization was done such that respondents whose occupations share similar characteristics will remain in one category for ease of analysis.

It came to light that 82 respondents fell into category 1 representing 22.9% of the sample with category 2 recording the least number of respondents of 8 persons representing 2.2%. Seventy respondents representing 19.6% and 46 respondents representing 12.8% fell into categories 3 and 4 respectively. Category 5 was the modal category with 122 respondents representing 34.1% of the sample while the final category of occupations had 30 respondents representing 8.4% of the sample. This is shown in Figure 5.3.

Agriculture recorded the least number of respondents probably because very few people are engaged in agriculture in the study area. Agriculture in Ghana is widely practiced in the forest and northern zones rather than in the Greater Accra Region where this study was done.

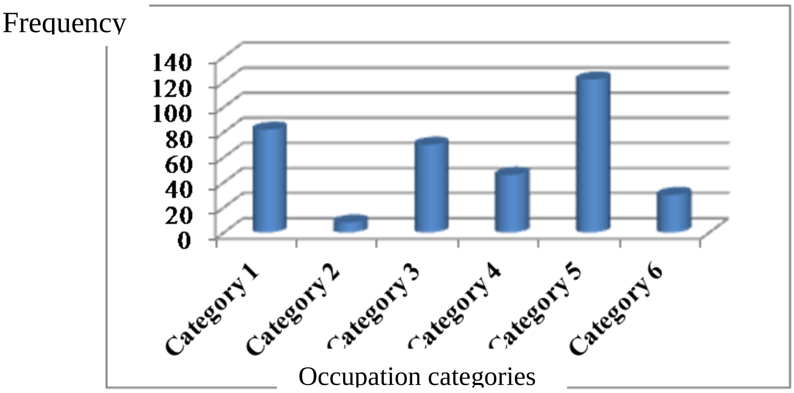


**Figure 5.3 Occupational distribution of the sample**
Source: Author's Survey, 2013.

Having properly explained the concept behind the study and the motivation for this study to the respondents before conducting the interviews, the predictable challenge of getting the right incomes of respondents in studies of this nature was minimized to a large extent. Most respondents gave us what is believed to be a fair value of the monthly incomes of their households. Other questions asked by the interviewers such as the number of income earners in the household and their occupations helped to come to the conclusion that the average monthly income values given by respondents is a fair reflection of the amount the household earns. The average monthly income of the respondents was GH¢ 1171.76 with minimum and maximum values of GH¢ 100.00 and GH¢ 4000.00 respectively.

### 5.2.2 Features of Existing Electricity Supply

All the households sampled for the survey receive their electricity supply from the Electricity Company of Ghana (ECG). However, almost all respondents described as wishful thinking if one expected to have uninterrupted supply of electricity continuously for a month. Table 5.1 shows the number of respondents who experienced power outages for a particular number of days on average in a month

**Table 5.1 Frequency of power outages in a month**

| Number of days | Frequency | Percentage |
|---|---|---|
| 1-3 | 28 | 7.8 |
| 4-6 | 78 | 21.8 |
| 7-9 | 87 | 24.3 |
| 10-12 | 50 | 14.0 |
| 13-15 | 33 | 9.2 |
| 16+ | 82 | 22.9 |
| Total | 358 | 100.0 |

Source: Author's Survey, 2013.

With respect to the frequency of outages in a month, Table 5.1 shows that about 87 respondents representing 24.3% of the sample experience power outages for between 7 and 9 days inclusive in a month while those who experience the least number of days of power outages of between a day and 3 days inclusive were the smallest. They made up 7.8% of the sample. 78 respondents representing 21.8% of the sample experienced power outages for between 4days and 6days inclusive whiles 22.9% of the sample experienced power outages for 16days and beyond. Information on the frequency of power outages is indicative of the severity of power interruptions in the metropolis for which this study is seeking to find the economic cost of.

Further quizzing revealed the duration of power outages as experienced by the respondents. Studies by Carlsson and Martinson (2004) and Pepermans (2011) have revealed that the duration of power outages is a significant factor in determining households' WTP in more advanced economies but studies in less advanced economies such as was carried out in Uganda and Kenya (Kateregga, 2009; Abdullah and Mariel, 2010 respectively) failed to show this. How much on average that an outage lasts on days that households experience power interruptions are presented in Table 5.2

**Table 5.2 Duration of power outages**

| Number of hours | Frequency | Percentage |
|---|---|---|
| 1-3 | 88 | 24.6 |
| 4-6 | 181 | 50.6 |
| 7-9 | 54 | 15.1 |
| 10-12 | 26 | 7.3 |
| 13-15 | 5 | 1.4 |
| 16+ | 4 | 1.1 |
| Total | 358 | 100.0 |

Source: Author's Survey, 2013

Regarding the average duration of an outage on days that outages are experienced, Table 5.2 shows that more than half of the sample (50.6%) experience outages of a period of between 4 and 6 hours inclusive on each day that their power supply is interrupted whiles 1.1% of the sample experienced outages that lasted beyond 15 hours in a day. For the least number of hours of outage of between an hour and 3hours inclusive, 88 respondents were recorded which represents 24.6% of the sample.

Households were asked to state the average amounts they spend on electricity monthly. Electricity bills were inspected for post paid customers while receipts were inspected for pre paid customers to verify the authenticity of the values they reported. The data revealed the mean cost of electricity to households to be GH¢ 59.71. The minimum cost was GH¢ 5.00 and the maximum cost was GH¢ 400.00. Closely related to the costs of electricity is the number of kilowatt hours of electricity consumed by households. It came to light that only 3 of the respondents fell into the 'lifeline' category by consuming less than 50 KWh of electricity monthly. They represented 0.8% of the sample. The next consumption bracket of 51 KWh – 300 KWh was the modal bracket taking up 236 respondents representing 65.9% of the sample. Seventy eight respondents representing 21.8% of the sample consumed between 301 KWh and

600 KWh of electricity every month while 7.3% of the sample consumed between 601 KWh and 1000 KWh of electricity. The number of people who consumed above 1000kWh of electricity monthly was 15 representing 4.2% of the sample. This information is displayed in Figure 5.4.

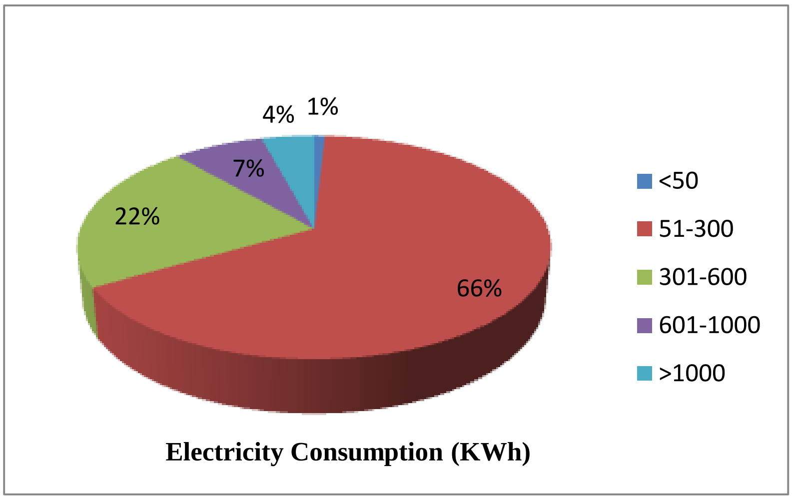


**Figure 5.4 Electricity consumption in kilowatt hours (KWh)**

Source: Author's Survey, 2013.

Households were further asked to rate the reliability and quality of the current electricity supply. By reliability, electricity supply was available regularly whiles quality refers to the stability of electric current or the appropriate voltage supplied. It was observed that 68.7% of respondents rated the electricity supply as unreliable while the remaining 31.3% rated it reliable. On the quality of supply or stability of current supplied, 51.7% rated the electricity current as stable while 48.3% rated it as unstable. Cross tabulation revealed that majority of those who experienced power outages for more days within a month are those who rated the electricity supply as unreliable whiles those who experienced power outages for fewer days in the month were those who rated the electricity supply as reliable.

Further questioning revealed that an overwhelming 94.1% of the respondents did not receive any notification prior to power interruptions. Only a minute 5.9% admitted that they received notification in advance of electricity outages.

### 5.3 Results from Ordered Probit Estimation

To investigate the factors that influenced WTP for improved electricity supply, responses from the survey were subjected to an ordered probit model regression analysis.

To begin with, a test was run to determine whether or not multicollinearity exists in the model. Multicollinearity exists in a model when two or more of the explanatory variables are highly correlated. To test for multicollinearity, a correlation matrix[8] was employed. Gujarati (2006 pp. 372) perceives multicollinearity to be a problem in a model when the pair-wise correlation coefficient is greater or equal to 0.8. From the correlation matrix (see: Appendix A), it can be seen that multicollinearity is not a problem in this model since none of the variables have a correlation coefficient of at least 0.8 with another variable.

The Pseudo $R^2$ of 0.0915 in Table 5.3 indicates that the explanatory variables fit the model by 9.15%. However, little emphasis is placed on this since 'goodness of fit' is not as important compared with the statistical and economic importance of the explanatory variables (Wooldridge, 2010 pp. 575). The Likelihood Ratio (LR) test statistic is 100.07 and it is $\chi2$ (10) distributed under the null hypothesis that all the variables together have no significant impact on WTP. The critical value for this distribution with $\alpha = 0.01$ is 23.21. This means with a $\chi2$ (10) value greater than the

[8] This study could not employ the more preferred Variance Inflation Factor (VIF) to test for multicollinearity because the study ran an Ordered Probit Model which is not compatible with testing for VIF. Under the circumstances, the correlation matrix was the best available technique to test for multicollinearity in this study.

critical value (100.07 > 23.21), we reject the null hypothesis and conclude that all the variables together have a significant impact on WTP.

The results from the ordered probit model are given in Table 5.3.

**Table 5.3 Results from Ordered Probit Model**

| | Dependent Variable: WTP | | |
|---|---|---|---|
| Variable (X) | Coefficient(β) | Std. Error | P>\|z\| |
| Current cost of electricity | 0.0013692 | 0.0011666 | 0.241 |
| Initial Bid | -0.0317776 | 0.0381246 | 0.405 |
| Sex of Respondent (Male=1; Female=0) | 0.1962805* | 0.1188163 | 0.099 |
| Household Size | -0.0612231*** | 0.0189476 | 0.001 |
| Household Income | 0.0005857*** | 0.0001042 | 0.000 |
| Highest education attained by respondent, Basic | 0.1939262 | 0.2939075 | 0.509 |
| Highest education attained by respondent, Secondary | 0.4083951 | 0.2860831 | 0.153 |
| Highest education attained by respondent, Tertiary | 0.5519966* | 0.3054697 | 0.071 |
| Reliability of existing supply (Reliable=1; Unreliable=0) | -0.3029989** | 0.1272467 | 0.017 |
| Prior notification to an outage (Given=1; Not given=0) | 0.2510964 | 0.2425754 | 0.301 |
| cut 1 | -0.0922526 | | |
| cut 2 | 0.4264143 | | |
| cut 3 | 1.44035 | | |
| cut 4 | 2.349381 | | |

| | |
|---|---|
| Log Likelihood | -496.63365 |
| LR $\chi 2$ (10) | 100.07 |
| Pseudo $R^2$ | 0.0915 |

*Significant at 10%, ** Significant at 5%, *** Significant at 1%

Source: Author's Estimation, 2013

With the exception of prior notification given before an outage, all other variables have their expected signs. However, not all the variables are statistically significant. The variables that were found to be insignificant are current cost of electricity, initial bid, prior notification given before an outage as well as basic and secondary education. This means that as far as the empirical estimation conducted in this study is concerned, these factors do not determine households' WTP for improved electricity supply in the Accra – Tema metropolis.

Household income is highly significant at 1% level of significance and it carried the expected sign, positive. An increase in household income will thus lead to increased values for households' WTP for improved electricity services. This result confirms the findings of Kateregga (2009) and that of Abdullah and Mariel (2010) that income is important in determining the amount African households are WTP for improvement. The result also conforms to economic theory which posits that income is positively related to a normal good such as improved electricity supply.

Household size is also highly significant at 1% level of significance. It confirms the findings of Abdullah and Mariel (2010) who also found family size to be important in determining WTP. However, household size has a negative sign in this study and thus negatively relates to WTP as opposed to the positive relationship reported between family size and WTP in the study of Abdullah and Mariel (2010). The negative sign in this study could be attributed to the fact that households with larger family sizes are more likely to incur higher expenditures in the daily upkeep of the family. And in the case where majority of the individuals in the household are not employed or are not earners, the burden of taking care of the members fall on the few earners which is enough strain on their finances. Such households will therefore have lower values for WTP since they will have to make room for other equally important expenditures as well besides expenditure on utilities.

Reliability of the current electricity supply was found to be statistically significant at 5% level of significance. It has a negative sign as expected. This means that as households' perception of the reliability of the current electricity supply increases, their WTP will fall. This is because, those to whom electricity supply is unreliable are more likely to pay more to better the service as compared to those to whom supply is already reliable.

The level of education of respondents has the expected sign, positive. Basic and secondary education levels are not significant but tertiary education is significant at 10% significance level. The magnitudes of the coefficients for the levels of education keep rising with each higher level which implies that as a person's level of education increases, he is more likely to value improved electricity supply because of the better and more rewarding uses to which such an educated person will put electricity. Such a person is therefore more inclined to pay for an improved electricity supply system. This finding that persons who have been educated at higher levels are willing to pay higher values for improvement in electricity and by generalization, utilities confirms the findings of other works done in other utility services such as water (Appau-Danso, 2004; Engel et al. 2005; Botchway, 2011).

Sex of the respondent was found to be statistically significant at 10% level of significance and confirms the work of Fissha (2006). What this implies is that men are more inclined to have higher values for WTP than women. This may be due to the fact that in the Ghanaian society, men are usually the ones who control household finances and take decisions about household spending and how much should be spent. As such, a man is more likely to state a high value as his WTP in an interview. If a woman is being interviewed on the other hand, she is less likely to state a high value for WTP because should it come to the actual payment, it may be her husband rather than herself who will make the payment or decide how much their household can pay.

The initial bid, though not significant is worthy of mention. This is because the initial bid was included as a regressor to test for the presence or otherwise of starting point bias which is a likely bias of the CVM. It has a negative sign and it is not significant. What this means is that statistically, the starting bids given respondents did not influence their ultimate WTP values. This shows the efficiency of the elicitation technique employed in this study over other elicitation techniques thus ruling out the starting point bias from this study.

As previously discussed, better interpretations of estimates from an ordered probit model can be made with the marginal effects. The marginal effect of changes in any explanatory variable is given by the partial derivative of the probability of each outcome of the dependent variable with respect to the particular explanatory variable under consideration. For any particular variable, the marginal effects for the various categories of the dependent variable sums to zero.

The marginal effects show the changes in probabilities for a unit change in an explanatory variable. For a dummy variable, however, the marginal effect is the change in the predicted probability if the explanatory variable changes say from 1 to 0 holding all other variables at their sample mean (Long, 1997). Table 5.4 presents the marginal effects for the various categories. In other words, it shows how the probability of households being within a particular WTP bracket changes as the values of the explanatory variables change.

**Table 5.4 Estimated Marginal Effects from the Ordered Probit Model**

| Variable | Pr(¢0.21) | Pr(¢ 0.24) | Pr(¢ 0.27) | Pr(¢ 0.30) | Pr(¢ 0.33) |
|---|---|---|---|---|---|
| Current cost of electricity | -0.000361 | -0.0001449 | 0.000056 | 0.000281 | 0.000169 |
| Initial Bid | 0.0083791 | 0.0033637 | -0.0012987 | -0.0065207 | -0.0039233 |
| Sex of Respondent (Male=1; Female=0) | -0.0523061 | -0.0204632 | 0.0088084 | 0.0401206 | 0.0238404 |
| Household Size | 0.0161432 | 0.0064805 | -0.0025022 | -0.0125629 | -0.0075587 |
| Household Income | -0.0001544 | -0.000062 | 0.0000239 | 0.0001202 | 0.0000723 |
| Highest education attained by respondent, Basic | -0.0486991 | -0.0213356 | 0.0043601 | 0.0397343 | 0.0259403 |
| Highest education attained by respondent, Secondary | -0.1015794 | -0.0446522 | 0.0076858 | 0.0827993 | 0.0557465 |
| Highest education attained by respondent, Tertiary | -0.1358314 | -0.0599699 | 0.0081717 | 0.1106098 | 0.0770198 |
| Reliability of existing supply (Reliable=1; Unreliable=0) | 0.0839028 | 0.030006 | -0.0181314 | -0.0613372 | -0.0344401 |
| Prior notification to an outage (Given=1; Not given=0) | -0.0594972 | -0.0286349 | 0.0004236 | 0.0511009 | 0.0366077 |

Source: Authors' Estimation, 2013

The marginal effects for household incomes are negative for GH¢ 0.21 and GH¢0.24 but positive for higher prices. This means that as incomes increase, the probability of a household having lower WTP values of GH¢0.24 and below decreases whiles the probability that households will be willing to pay higher prices increases with an increase in income. From table 5.4, for a 1% increase in the income levels, there is a 0.0072% chance that households in the Accra – Tema metropolis will be willing to pay GH¢ 0.33 per kilowatt hour for improved electricity services and a 0.012% chance that households will be willing to pay an amount of GH¢ 0.30 per KWh. For a 10% increase in income levels, the probabilities are 0.072% and 0.12% that households will pay GH¢ 0.33 per KWh and GH¢0.30 per KWh respectively. As already indicated, both theory and earlier empirical studies within the African context confirm the significance of income in determining households' WTP for improvement in electricity improvement.

The marginal effects of household size are positive for prices below GH¢ 0.25 but negative for prices above GH¢ 0.25. This means that as household size increases, the probability of a household paying less than GH¢0.25 increases whiles the probability of paying higher than GH¢0.25 decreases. Thus, to increase households' WTP for improved electricity, people should be encouraged to have smaller family sizes. As household size increases by 1%, the probability that a household will pay an amount of GH¢0.30 will fall by 1.26% whiles the probability that a household will pay GH¢0.33 will fall by 0.76%. The probability that households will pay lesser values for the same 1% increase in household size is positive. There is a 1.6% chance that households will pay an amount of GH¢0.21 and a 0.6% chance that households will pay GH¢0.24 per KWh for a 1% increase in household size.

With reference to household heads who have no formal education, the marginal effects of those who have attained up to secondary education as well as those with tertiary education are negative at prices below GH¢ 0.25 but positive at higher prices. It is also observed that the marginal effects get higher as the level of education increases. This means respondents with higher levels of education are more likely to pay higher values for improved services. The results indicate that the probability of paying GH¢0.33 is 0.02 (0.0770-0.0557) more for individuals with tertiary education than for individuals with secondary education whiles the probability is 0.03 (0.0557-0.0259) higher for individuals with secondary education than for individuals with basic education. Respondents with tertiary education have a probability of 0.11 higher than respondents with no formal education of paying an amount of GH¢0.30 per KWh for improved electricity supply.

It is more likely that men will be more willing than women to pay higher prices of above GH¢0.26 than women will do for improved electricity and women are more likely to be willing to pay lower prices of less than GH¢ 0.25. From the estimated marginal effects, it is noted that the probability of paying any amount for improvement in electricity supply is higher for men than for women. The probability of paying GH¢0.30 for electricity improvement is 0.04 higher for men than for women whiles the probability that a man will pay GH¢0.33 is 0.024 higher than the probability for a woman to pay that amount.

Respondents who deem the current supply to be unreliable are more likely to pay an amount greater than GH¢ 0.26 for improvement whiles those who perceive the current supply to be reliable are more likely to pay a lower price of less than GH¢0.25. The probability of a household paying an amount of GH¢0.27 per KWh is 0.018 times lower for respondents who deem current supply to be reliable than for those who deem it unreliable whiles the probability of paying GH¢0.33 per KWh for improvement in electricity is lower by 0.034 for households whose electricity supply is reliable than for those whose supply is unreliable.

### 5.4 Computing the Total Willingness to Pay

Analyzing the responses on the maximum amount households are willing to pay for the proposed improved electricity supply revealed that the mean WTP is GH¢0.2667 per KWh. It implies that on average, every household in the Accra –Tema metropolis is prepared to pay GH¢0.2667 for a kilowatt hour of electricity if and only if this comes with an improved electricity supply where there are no interruptions and power outages hardly or in the extreme case never occur. This amount is about 46.7% higher than the current tariff which averages at GH¢ 0.1818 per KWh across all consumption categories.

**Table 5.5 Descriptive statistics of maximum WTP**

| Mean | Median | Mode | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| GH¢ 0.2667 | GH¢ 0.2700 | GH¢ 0.20 | GH¢ 0.05116 | GH¢ 0.20 | GH¢ 0.50 |

Source: Author's Survey, 2013

The total amount households are willing to pay to improve electricity is used as a measure of the value of the cost of poor electricity supply to the metropolis. Thus, how much households are willing to pay is the economic cost of power outages in the metropolis. To arrive at this, the mean WTP from the sample is extrapolated across the population.

According to the 2010 population and housing census report, the number of households within the Accra – Tema metropolis is estimated to be 599,553 (GSS, 2012). Per the data collected from the CV survey, the average monthly cost of electricity consumed by each household is GH¢ 59.71. Dividing this amount by the cost per unit of electricity consumed, GH¢0.1818 to arrive at the average number of kilowatt hours of electricity consumed monthly by households gives 328.438kWh.

For the total number of households in the metropolis therefore, the total electricity that is consumed monthly comes to 196,915,988.2KWh (599,553*328.438KWh).

To estimate the total willingness to pay, the mean WTP from the sample is used to represent the mean WTP for the population. Using the population mean permits us to extrapolate the estimates for the entire population. The total WTP is given by:

$$TWTP = (mWTP) \times N \qquad \ldots\ldots\ldots\ldots\ldots\ldots (5.1)$$

Where TWTP = Total Willingness to pay

mWTP = population mean Willingness to pay per kilowatt hour of electricity

N = Total kilowatt hours of electricity consumed by the total number of households in the metropolis.

Substituting the appropriate figures into equation 5.1yields:

TWTP = GH¢0.2667 * 196,915,988.2

TWTP = GH¢52,517,494.05

The total willingness to pay to improve electricity is used as a measure of the economic cost of power outages in the metropolis. This is the amount that households in the metropolis are willing to give up in order to avoid incurring the cost of outages by improving electricity supply. Studies such as Mensah (2011), Botchway (2011) have all proxied the economic cost of an adverse situation by the total willingness to pay to avoid it or to improve upon the situation. Therefore, the economic cost of power outages to households in the Accra-Tema metropolis is estimated to stand at GH¢52,517,494.05monthly (GH¢630,209,928.6 annually). The fact that poor electricity supply brings huge costs to households in the metropolis cannot be overemphasized and it is indicative of how negatively it impacts on the standards of living of the populace.

**5.5 Willingness to Pay and Total Revenue**

This section estimates the total revenue that will accrue at different tariffs per KWh of electricity. Again, use is made of extrapolation of the sample results to apply to the population

**Table 5.6 Total WTP and Total Revenue for Improvement in Electricity Supply**

| WTP Category (GH¢) | Mid point WTP (GH¢) | No. of Households | % of sample | Share of popn | Cumm Popn | Total no. of kWh consumed monthly | Total WTP per month (GH¢) |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E=D*599553 | F | G=F*328.438 | H=B*G |
| ≥ 0.32 | 0.33 | 33 | 9.22 | 55,278.79 | 55,278.79 | 18,155,655.23 | 5,991,366.2 |
| 0.29-0.31 | 0.30 | 75 | 20.95 | 125,606.35 | 180,885.14 | 59,409,553.61 | 17,822,866.1 |
| 0.26-0.28 | 0.27 | 119 | 33.24 | 199,291.42 | 380,176.56 | 124,864,429 | 33,713,395.8 |
| 0.23-0.25 | 0.24 | 52 | 14.53 | 87,115.05 | 467,291.61 | 153,476,321.8 | 36,834,317.2 |
| 0.20-0.22 | 0.21 | 79 | 22.06 | 132,261.39 | 599553 | 196,915,988.2 | 41,352,357.5 |
| Total | | 358 | 100 | 599553 | | | |

Source: Author's Survey, 2013

Table 5.6 has been drawn to reveal the total revenues that should be expected by power utilities at the different tariff levels if there is an improved electricity supply system in place. This is to help the utilities know the approximate amounts to expect in total revenues at various tariff levels if they should decide to improve electricity supply in the metropolis to a level such as was described in the hypothetical scenario. The works of Mensah (2011) and Adjei (1999) also employed this approach to give service providers an idea of revenues to expect at different prices. From Table 5.6, it is revealed that charging an amount of GH¢0.21 per kilowatt hour of electricity will yield monthly total revenue of GH¢ 41,352,357.5 which is the maximum total revenue that can be realized. At this tariff rate, the entire population of electrified households in the metropolis can access the improved electricity. As such, if it is the goal of the utility provider to increase coverage of improved electricity supply given its importance and benefits to the general populace, then this tariff rate would be most appropriate.

### 5.6 Summary of chapter

This chapter discussed the results obtained in the study. Concerning the current supply of electricity, over 94% of households bemoaned the inability of the service providers to notify them prior to an outage while more than two-thirds of the sample rated their supply of electricity as largely unreliable. The chapter went on to reveal that households in the metropolis are willing to pay almost GH¢ 0.27 per KWh of electricity, an amount nearly one and half times the existing tariffs, if and only if they will have an improved supply. The chapter further confirmed that the poor electricity supply being experienced within the Accra-Tema metropolis comes at a great cost to households to the point that households are willing to pay GH¢52,517,494.05 monthly (GH¢ 630,209,928.6 annually) to avoid it and to have an improved electricity supply. Among the significant factors that have been identified to influence households' WTP include household income, sex of respondent, the size of a household, tertiary educational level of the respondent and the reliability of existing supply.

# CHAPTER SIX

# SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

## 6.1 Introduction

This chapter concludes the study by providing a summary of the entire study. The findings from the study are also summarized in this chapter. These findings serve as basis on which recommendations have been made for policy makers to consider. Limitations of this study have also been outlined in this chapter and the final section of the study gives recommendations for future research.

## 6.2 Summary of the study

Electricity is essential for the development of any nation. Many industrial, commercial and household activities require constant availability of power. In developing economies such as Ghana, the case is no different. However, constant provision of electricity leaves much to be desired in the country. Utility providers in the power sector have usually blamed the poor supply of electric power on some factors they face in the discharge of their duties prime among which is the low tariffs paid by consumers of electricity especially household consumers. Due to the unavailability of constant electricity supply, household consumers do suffer losses some of which bring huge economic costs to household consumers. The economic costs borne by households may be quite high to the extent that households may be prepared to pay to avoid bearing these losses arising from poor electricity supply. It is against this backdrop that this study sought to investigate the economic costs of frequent power outages in the Accra – Tema metropolis and to know how much consumers are willing to pay to receive improved electricity services as well as examine the factors that influence households' WTP.

An overview of the electricity sub sector in Ghana showed that electricity in the country is generated through hydro and thermal sources. Hydro sources' have contributed more to electricity generation than thermal sources over the years. However, the contribution of thermal sources to electricity generation has seen a steady increase in recent years due to the increased addition of more thermal plants to the generation capacity by both the government and the private sector. It was further revealed that both demand and supply of electricity have increased steadily in the past ten years except for a few years where a decline in production was recorded due to external shocks in production. Ghana's agreement to the ECOWAS Energy Protocol requires her to remove all barriers to energy trade. This means that Ghana trades energy with her neighbours. In recent years, Ghana has recorded negative net imports with respect to electricity trade. This means the country improves her foreign reserves by exporting more electricity than she imports. A review of tariffs also revealed that end user tariff (EUT) which is the final tariff paid by consumers was observed to have increased from 3.9 Ghp/KWh in the year 2001 to 22.34 Ghp/KWh in the year 2012 with an average annual growth of 20.64%.

A review of the literature showed that electricity demand is basically affected by three main factors namely price of electricity, price of other sources of energy and real income of consumers. However, specific studies have shown isolated cases where other factors such as prices of appliances, industry efficiency, demographic features among others also affect the demand for electricity. Reviewing literature on methods of non market valuation showed that the CVM which was employed in this study stands tall among other valuation methods since the CVM is able to measure both use values and non use values of a resource while most other methods are able to measure only use values. A review of the empirical literature showed that studies have been conducted in different parts of the world on WTP to improve electricity supply. However, though most of the studies showed that inadequate electricity was a cost to most households, not all the studies showed a definite response to the issue. While studies in more advanced economies showed that households were willing to pay significantly to avert these costs, not all the studies in developing countries shared this view.

The study conducted a survey to collect data from primary sources and employed the theoretical framework employed by Botchway (2011) to come out with a model. Factors that dominated the literature also informed the formulation of the model. The ordered probit model was used to estimate the significant factors that affect WTP.

In the course of undertaking this study, a number of revelations were made about the current provision of electricity to households in the metropolis. The study revealed that current power supply is deemed by majority of households to be unreliable and the quality of electricity supply needs to be improved. It was further revealed that service providers have performed abysmally with regards to giving consumers advanced notice in the event of power outages.

A contingent valuation survey was conducted where a hypothetical case of an improved electricity supply system was given to households who were then asked how much they would be willing to pay to receive an electricity supply system with those improved features. On average, households are willing to pay about 47% above the current electricity tariffs. Precisely, households in the metropolis are prepared to pay nearly GH¢0.27 per kilowatt hour of electricity. It is important to note that households are willing to pay this amount if and only if electricity supply is improved and has the features of the hypothetical electricity supply scenario presented to households.

Further calculations based on the data collected revealed that the current unreliable supply of electricity costs households in the metropolis and therefore society as a whole a monthly amount of GH¢52,517,494.05. The opportunity cost of this amount is the various interventions that could be made to improve the welfare of the ordinary Ghanaian. This explains the reason households are willing to pay significantly to avert this huge power outage cost.

Variables that were found to significantly impact on households' WTP include household income, sex, tertiary level of education of the household head, reliability of existing supply as well as household size. Other variables included in the empirical estimation were found to be insignificant in determining households' WTP.

## 6.3 Conclusion

In conclusion, it is evident from the empirical work done in this study that households in the Accra-Tema metropolis do not receive adequate electricity and they are adversely affected by this poor electricity supply. To improve electricity, they are prepared to pay an average amount of GH¢ 0.2667 per KWh of electricity which is nearly one and half times the current tariffs they pay. Households are prepared to pay this amount if and only if electricity supply is improved and made more reliable without power outages. Factors that influence the households' WTP include household income, household size, sex, tertiary level of education of the head of the household and the reliability of current supply.

## 6.4 Policy Recommendations

On the basis of the findings, the following recommendations are made for policy consideration.

- ✓ Government should invest heavily in infrastructure in the power sector and increase tariffs since households in the Accra – Tema metropolis are prepared to pay about one and a half times more than what they are paying now if they will be provided improved electricity supply. Evidently, it may not be possible to obtain funds for the huge capital investment required in the sector. Government can therefore select and use some parts of the metropolis to pilot the project of providing improved power supply and up-scale it to other parts of the metropolis and subsequently other parts of the country based on experience and lessons. This pilot scheme could also be done through public private partnerships since a blend of private economic objectives and public social objectives will improve efficiency and lead to an optimal development path.

- ✓ Household income has a strong positive relationship with WTP. As such to increase households' preparedness to pay for improved electricity, measures should be undertaken to increase the incomes of the households. Such measures may include increasing the national daily minimum wage so that incomes will go up significantly. Measures should also be undertaken to provide jobs for the unemployed. This way, the incomes of previously unemployed persons who now have jobs will add to their households' incomes to enhance their households' willingness to pay.
- ✓ The study also revealed a strong negative relationship between household size and WTP. It is recommended that measures be embarked upon to encourage people especially the younger generation who are yet to have children of their own to have smaller family sizes rather than larger ones. The state may resort to public education to impress upon people to reduce the number of children they intend to have so that their incomes will be well able to cater for their household expenditures and subsequently make room for increased WTP.

- ✓ The study further showed that people with increased levels of education had higher WTP. It is therefore recommended that the national agenda on child education be taken seriously. Additionally, not only basic education should be made compulsory as it stands at the moment; rather, secondary education should be made a must for all persons to further increase the percentage of the population who attain tertiary education. Since people who have higher education have higher WTP for electricity, it is recommended that as far as possible, the service providers employ the use of price discrimination to charge persons with higher education higher tariffs than persons with lower education. This can be done if further research is carried out to know if the highly educated persons have a particular trend of electricity consumption for example through the use particular appliances. If a clear pattern is observed, it can be used to price electricity higher for the highly educated than persons with low levels of education.
- ✓ Since electricity produced from hydro sources are cheaper as compared to electricity produced via thermal sources, it is recommended that more hydro dams be built with the increased revenues from the increased tariffs. Though their startup capital is huge, once the dams have been constructed, the marginal cost of producing electricity will be lower to further increase profits. An additional advantage of this is that potential shocks on thermal plants such as fuel shortages will not hinder the continuous supply of power as experienced in Ghana in the year 2012. This way, reliability of electricity supply can be assured.

In the course of undertaking the field survey, some observations were made by the researcher from which the following recommendations have been proposed.

- ✓ It was observed that quite a number of households especially in the congested suburbs of the metropolis are illegally connected to electricity. This means that they do not pay any tariffs for the electricity they use and this constitute a huge drain on the profitability of the service providers. It is recommended that unannounced swoops be carried out in some of these localities to apprehend offenders and bring them to book.
- ✓ It was also observed that quite a number of persons undertake commercial activities on relatively large scales using electricity from their homes. There are many people who mill corn, do tailoring or dressmaking, hairdressing, own relatively big shops among others in their homes. They use up electricity but since they are connected to residential meters, they pay residential rates even though they use some of the electricity for commercial purposes. It is recommended that the service providers investigate this phenomenon and install commercial meters for these commercial activities so that the appropriate tariffs would be paid to enhance the revenue base of the service providers.

### 6.5 Limitations of the Study

This study did not take into account the costs involved in providing the improved electricity supply system with all the benefits described in the hypothetical scenario since that was not the focus of this study. Even though this study provides estimates of tariff levels that would yield maximum revenues from implementing the improved electricity supply system, further technical analyses need to be done to know the total costs of providing the uninterrupted electricity supply system.

Furthermore, this study did not research into how the service provider can effectively discriminate price in favour of persons with lower education. Neither did the study research into how the trend of persons undertaking commercial activities but paying residential rates can be reversed.

Financial as well as time constraints partly limited the scope of the study. But for time and funding, many more households would have been interviewed to widen the scope of this study to better represent the views of the metropolis.

**6.6 Recommendations for Future Studies**

Having established that power outages are a cost to households and further establishing that households are willing to pay significantly to improve electricity supply, it is recommended that future studies should concentrate on researching into what the total costs of providing such an improved electricity supply would be. This should help inform authorities and aid proper planning before the project begins. Knowledge of the total costs will also lead the service provider to know which tariff level will yield optimum profits (that is in the case where the goal of providing an improved electricity supply system is to maximize profits).

Secondly, having recommended price discrimination in favour of persons with lower education based on findings from this study, it is recommended that further studies be conducted into how this price discrimination can be done in a way that will make very highly educated persons pay higher tariffs since they are prepared to pay it than persons with lower levels of education.

# REFERENCES

Abdullah, S. and Mariel, P. (2010) 'Choice experiment study on the willingness to pay to improve electricity services'. *Energy Policy*, vol. 38 pp. 4570-4581.

Adenikinju, A. (2005) 'Analysis of the cost of infrastructure failures in a developing economy: the case of the electricity sector in Nigeria'. *AERC Research Paper* 148.

Adjei, O. (1999) 'Willingness to pay for improved water supply in the Greater Accra Metropolitan Area'. An unpublished MPhil thesis, University of Ghana.

Adom, P. K. (2011) 'Energy demand in Ghana: A case study of the electricity sub sector'. An unpublished MPhil thesis, University of Ghana.

Adom, P.K. Bekoe W. and Akoena S. K. K. (2012) 'Modelling aggregate domestic electricity demand in Ghana: An autoregressive distributed lag bounds cointegration approach'. *Energy Policy*, vol 42 pp. 530-537.

Aguilar, M. and Sterner, T. (1995) 'Willingness to pay for improved communal water services'. *EEU working papers*, Gothenburg University, Sweden.

Appau-Danso, E. (2004) 'Willingness to pay for improved water supplies in rural communities. A case study of the Asante Akim South District'. An unpublished mphil thesis, University of Ghana.

Babatunde, M. A. and Shuaibu, M. I. (undated) 'The demand for residential electricity in Nigeria: a bound testing approach'. Accessed at http://www.africametrics.org/documents/conference09/papers/Babatunde_Shuaibi.pdf

Bishop, R. C. and Heberlein, T. A. (1979) 'Measuring values of extra-market goods: Are indirect measures biased?' *American Journal of Agricultural Economics*, vol. 61, no. 5, pp. 926-930.

Bishop, R. C. Heberlein, T.A. and Kealy, M. J. (1983) 'Contingent valuation of environmental assets: comparisons with a simulated market'. *Natural Resources Journal*, vol. 23, pp. 619-634.

Botchway, E. (2011) 'Willingness To pay for improved water supply in the Accra Tema Metropolis'. An unpublished MPhil thesis, University of Ghana.

Cameron, A. C. and Trivedi, P. K. (2005) *Microeconometrics-Methods and Applications*. New York: Cambridge University Press.

Carlsson, F. and Martinsson, P. (2004) 'Willingness to pay among swedish households to avoid power outages'. *Working papers in Economics*, no. 154.

Carson, R. T. and Mitchell, R. C. (1981) 'An experiment in determining willingness to pay for national water quality improvements'. A draft report to the US Environmental Protection Agency, Washington DC.

Carson, R. T. and Mitchell, R. C. (1984) 'A contingent valuation estimate of national freshwater benefits: Technical report to the US Environmental Protection Agency'. *Resources for the Future*, Washington, D.C.

Davis, R. (1963) 'Recreation planning as an economic problem'. *Natural Resources Journal* vol. 3, no. 2, pp. 239-249.

Damigos, D. Tourkolias, C. and Diakoulaki, D. (2009) 'Households' willingness to pay for safeguarding security of natural gas supply in electricity generation'. *Energy Policy,* vol. 37 pp. 2008-2017.

De Vita G. Endresen K. and Hunt L. C. (2006) 'An empirical analysis of energy demand in Namibia'. *Energy Policy* 34, pp. 3447–3463.

Diabi, A. (1998) 'The demand for electricity in Saudi Arabia: an empirical investigation'. OPEC Review. *Energy Economics and Related Issues* 22(1), pp. 12–17.

Electricity Company of Ghana (2013) 'Electricity Company of Ghana: Proposal for review in distribution service charge'. Accra, Ghana.

Energy Commission (2011) 'Annual Report'. Accra, Ghana.

Engel, S. Iskandarani, M. and Usache, M. P. (2005) 'Improved water supply in the Ghanaian Volta Basin: Who uses it and who participates in community decision making?' *IFPRI, EPT Discussion Paper*, No. 129.

Fissha, M. (2006) 'Household demand for improved water service in urban areas: The case of Addis Ababa, Ethiopia'. Unpublished MSc Thesis, Addis Ababa University.

Filippini, M. and Pauchauri, S. (2002) 'Elasticities of electricity demand in urban Indian households'. *CEPE Working paper* No.16.

Foley, A. M. Ó Gallachóir, B. P. Hur, J. Baldick, R. and McKeogh, E.J. (2010) 'A strategic review of electricity systems models'. *Energy Policy*, vol. 35 pp. 4522-4530.

Garrod, G. D. and Willis, K. G. (1999) *Economic Valuation of the Environment*. Cheltenham, UK: Edward Elgar Publishing Ltd.

Ghana Statistical Service (2008) 'Ghana Living Standards Survey: Report of the Fifth Round (GLSS 5)'. Ghana Statistical Service, Accra.

Ghana Statistical Service (2012) '2010 Population and housing census; summary report of final results'. Ghana Statistical Service, Accra.

Greene, W. H. (2008) *Econometrics Analysis*. Sixth Edition, New Jersey: Prentice Hall.

Gujarati, D. N. (2006) *Essentials of Econometrics*. Third edition. McGraw-Hill, Irwin.

Hanley, N. Shogren, J. F. and White, B. (2002) *Environmental Economics in Theory and Practice.* New York: Palgrave MacMillan.

Hensher, D. Shore, N. and Train, K. (2005) 'Households' willingness to pay for water service Attributes'. *Environmental and Resource Economics,* vol. 32 pp. 509-531.

Hicks, J. R. (1941) 'The rehabilitation of consumers' surplus'. *Review of Economic Studies,* vol. 8, no. 2, pp. 108-116.

Institute of Statistical, Social and Economic Research (2005) *Guide to Electric Power in Ghana*. First edition. Accra: ISSER

Institute of Statistical, Social and Economic Research (2004, 2008, 2012) *State of the Ghanaian Economy*. Accra: ISSER

Kateregga, E. (2009) 'The welfare costs of electricity outages: A contingent valuation analysis of households in the suburbs of Kampala, Jinja and Entebbe'. *Journal of Development and Agricultural Economics*, vol. 1 pp. 001-011.

Lancaster, K. (1966) 'A new approach to consumer theory'. *Journal of Political Economy* 74, 132–157.

Lareau, T. and Rae, D. (1987) 'Valuing willingness to pay for diesel reduction odours'. *Southern Economics Journal*, pp. 728-7742.

Li, C. J. Löfgren, K. G. and Hanemann, W. M. (undated) 'Real versus Hypothetical Willingness to Accept: The Bishop and Heberlein Model Revisited'. Accessed at http://www.nek.uu.se/StaffPages/Publ/P654.pdf

Long, J. S. (1997) *Regression Models for Categorical and Limited Dependent Variables.* Advanced Techniques in the Social Sciences, vol. 7. California: SAGE Publications Inc.

Maddala, G. S. (1983) *Limited-Dependent and Qualitative Variables in Econometrics*. New York: Cambridge University Press.

McFadden, D. (1974) *Conditional logit analysis of qualitative choice behavior*. In: Zarembka, P. (Ed.), Frontiers of Econometrics. Academic Press.

McNair, B. J. Bennett, J. Hensher, D. A. and Rose, J. M. (2011) 'Households' willingness to pay for overhead-to-underground conversion of electricity distribution networks'. *Energy Policy*, vol. 39 pp. 2560-2567.

Mensah, J. T. (2011) 'Estimating the economic costs of road accidents caused by faulty vehicles parked along the road'. An unpublished MPhil thesis, University of Ghana.

Mishra, S. K. (undated) 'Valuation of environmental goods and services: An institutionalistic Assessment'. Accessed at https://www.msu.edu/user/schmid/mishra.htm

Munasinghe, M. (1980) 'Costs incurred by residential electricity consumers due to power failures'. *Journal of Consumer Research*. The University of Chicago Press.

Narayan, P. K. and Smyth, R. (2005) 'Trade liberalization and economic growth in Fiji: An empirical assessment using the ARDL approach'. *Journal of the Asia Pacific Economy* 10, 96–115.

National Oceanic and Atmospheric Administration (1993) 'Report of the NOAA panel on contingent valuation'. *Federal Register*, vol. 58, no. 10, pp. 4601-4614.

Pearce, D. W. and Turner, R. K. (1990) *Economics of Natural Resources and the Environment*. Harvester: Hemel Hempsted.

Pepermans, G. (2011) 'The value of continuous power supply for Flemish households'. *Energy Policy*, vol. 39 pp. 7853-7864.

Perman, R. Ma, Y. McGilvary, J. and Common, M. (2003) *Natural Resources and Environmental Economics*. Third Edition, London: Pearson Addison Wesley.

Public Utilities Regulatory Commission (1999) 'Electricity Rate Setting Guidelines'. Public Utilities Regulatory Commission, Accra, Ghana.

Serra, P. and Fierro, G. (1997) 'Outage costs in Chilean industry'. *Energy Economics*, vol. 19 pp. 417-434.

Vásquez, W. F. Mozumder, P. Hernández-Acre, J. and Berrens, R. P. (2009) 'Willingness to pay for safe drinking water: Evidence from Parral, Mexico'. *Journal of Environmental Management*, 90 (2009) pp 3391-3400.

Volta River Authority (2012) 'VRA brochure'. Accra, Ghana.

Walker, J. and Ben-Akiva M. (2002) 'Generalized Random Utility Model'. *Mathematical Social Sciences* 43 pp. 303-343

Wooldridge, J. F. (2010) *Econometric Analysis of Cross Section and Panel Data*.: Cambridge, Massachusetts: MIT Press.

http://www.myjoyonline.com (2013)

# APPENDICES

## APPENDIX A: Test for Multicollinearity: Pairwise Correlation Matrix

| | CCEL | IB | HSIZ | HINC | BEDU | SEDU | TEDU | REL | PRNTF | SEX |
|---|---|---|---|---|---|---|---|---|---|---|
| CCEL | 1 | | | | | | | | | |
| IB | 0.10109 | 1 | | | | | | | | |
| HSIZ | -0.00502 | 0.09655 | 1 | | | | | | | |
| HINC | 0.41557 | 0.04449 | 0.11338 | 1 | | | | | | |
| BEDU | -0.15912 | 0.05452 | 0.14166 | -0.3075 | 1 | | | | | |
| SEDU | -0.18758 | -0.065 | 0.04343 | -0.1928 | -0.40239 | 1 | | | | |
| TEDU | 0.34414 | 0.00513 | -0.1955 | 0.53447 | -0.41986 | -0.55977 | 1 | | | |
| REL | 0.11634 | 0.00512 | -0.1104 | 0.16697 | -0.0709 | -0.11508 | 0.196098 | 1 | | |
| PRNTF | -0.06734 | -0.0572 | 0.01997 | -0.0474 | -0.05264 | 0.066519 | -0.06758 | -0.01461 | 1 | |
| SEX | 0.12895 | 0.04392 | -0.1302 | 0.10834 | -0.16808 | -0.01395 | 0.185383 | 0.134977 | -0.06685 | 1 |

APPENDIX B: Contingent Valuation Survey Questionnaire

# CONTINGENT VALUATION SURVEY

| | Code | Enumeration Area | |
|---|---|---|---|

Interviewer……………………………………..

Place of Interview……………………………………

Date of Interview………………………………………

UPPER CASE LETTERS INDICATE INSTRUCTIONS FOR INTERVIEWERS

Lower case letters indicate questions and information to be read to the interviewee.

**INTRODUCTION**

Hello, I am_________________, a research enumerator from the University of Ghana assisting in data collection for an ongoing research by Mr Kwame Adjei-Mantey for the award of Mphil Economics degree. We are interviewing a sample of households in the Accra – Tema Metropolis with the aim of estimating the WTP for uninterrupted electricity supply in the metropolis. Please be assured that information provided would not in any way be linked to you and would be treated with utmost confidentiality. This interview is completely confidential and strictly for academic purposes and therefore honest discussion is the best way ahead.

**SECTION A: EXISTING ELECTRICITY SUPPLY AND ASSOCIATED ISSUES**

A1. Averagely, how many days in a month does power go off (at least once)? ………………………………..

A2. On average, how many hours does it take when power goes off (on days that it does)?

………………………………

A3. Approximately how many kilowatt-hours of electricity do you consume every month? …………………

……...kwh

A3. Averagely, how much do you pay monthly for electricity? Ghc………………… ……...Gp

ASK RESPONDENT TO PROVIDE A COPY OF THE BILL FOR THE PAST 3-4 MONTHS AND RECORD THE MONTH, AMOUNT AND KWH CONSUMED. AT LEAST PLEASE GET ONE BILL. IF IT IS A COMPOUND HOUSE YOU MAY NOT GET THIS INFORAMATION.

Month : …………………………………… Amount (GHC): ………………………………Kwh consumed:………………..

Month : ………………………………….. Amount (GHC): …………………………….. Kwh consumed:…………………

Month : …………………………………. Amount (GHC):…………………………….. Kwh consumed:.....................

A4. What is your alternative source of power when electricity goes off?

1. Generator 2. Solar energy 3. Inverters 4. Torch light 5. Gas lights 6. No alternative 5. Other (specify)…………………………….

A5. On the average, how much do you spend on this alternative source of power during power outages

in a month? Ghc……………. ……..Gp

A6. How necessary do you consider the current supply of electricity an issue worth discussing?

1. Extremely necessary 2. Very necessary 3. Necessary 4. Moderately Necessary 5. Not Necessary

A7. How would you rank the current supply of electricity to your home/ neighbourhood?

A. RELIABILITY (available at every time.):
   1. Excellent 2. Very Reliable 3. Reliable 4. Moderately Reliable 5. Not reliable

B. QUALITY ( appropriate level of voltage and/or non fluctuating or stable current):

   1. Excellent 2. Very good 3. Good 4. Poor 5. Very poor

C. PRIOR NOTIFICATION GIVEN BEFORE AN OUTAGE

   1. Excellent 2. Very Good 3. Good 4. Poor 5. Very Poor

A8. Do you think the appropriate authorities have done enough to solve or at least deal with the problems of providing reliable and quality electricity supply?

1. Yes 2. No

SECTION B: WILLINGNESS TO PAY

HYPOTHETICAL SCENARIO

In this section, I would like to ask you how much it is worth to you in monetary terms, the supply of uninterrupted and quality electricity supply. The supply of uninterrupted electricity among other things means, good quality electricity which includes constant, non fluctuating current and safe for all household gadgets. Uninterrupted electricity also means power outages are to some extent ruled out or at worst reduced to its barest minimum. (It will occur only when there is a spontaneous technical fault or when there is going to be some repairs and even in the event of such rare outages occurring, you will be pre informed before it occurs and it will not take more than two hours). This means that there will not be the need for any alternative source of power.

Let us assume that you have an option for a private connection to such an uninterrupted quality electricity supply scheme and you will be charged a monthly user fee based on the quantity of electricity your household consumes in a month. At the moment, you are paying on average, about Ghc 0.19 for a kilowatt-hour for the current unreliable power supply.

ASK THE WILLINGNESS TO PAY QUESTIONS

B0. Will your household be willing to pay higher for this service?

1. Yes
2. No

B1. Will your household be willing to pay Ghc………………… per kilowatt hours for this service?

3. Yes GO TO B2
4. No GO TO B3

IF YES, INCREASE BID BY GHC…… IF NO, REDUCE BID BY GHC…………

B2. If the service provider decides that the household pays Ghc…………….. per kilowatt hours, will your household be willing to pay for the service?

1. Yes GO TO B4
2. No GO TO B6

B3. If the service provider decides that the household pays Ghc………………per kilowatt hours, will your household be willing to pay for the service?

1. Yes GO TO B6
2. No GO TO B5

B4. Will your household be willing to pay Ghc……………….for this service?

1. Yes GO TO B6
2. No GO TO B6

B5. Will your household be willing to pay Ghc…………………for this service?

1. Yes GO TO B6
2. No GO TO B6

B6. Think carefully for a moment. What is the maximum amount your household will be willing to pay to use this service such that if it would cost more than this amount, your household would not be able to pay and hence you cannot have this uninterrupted electricity supply service?

Ghc………………………..per kilowatt hours.

SECTION C: SOCIO ECONOMIC CHARACTERISTICS

C1. Sex : 1. Male 2. Female

C2. Age: 1. ≤ 29yrs 2. 30-39yrs 3. 40-49yrs 4. 50-59yrs 5. ≥ 60yrs.

C3. Highest Educational Level: 1. No formal education 2. Basic 3. Secondary 4. Tertiary

C4. On the average how much do you spend in this household in a month?.......................................

C5. What is your main occupation?
……………………………………………………………………………………….

C6. Do you have other jobs you do besides your main occupation? If yes, what are they?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………..

C7. How many individuals are in this household?...................................................

C8. How many of them are working?...................................................................

C9. What is the total household monthly income? ie. The sum of incomes of all persons who are working in this household in a month

Ghc…………………. …………Ghp

**THANK YOU**